Quarterly Journal
of the
Florida Academy of Sciences

Vol. 35 March, 1972 No. 1

CONTENTS

The Armadillidae of Florida (Isopoda, Oniscoidea) *George A. Schultz* 1

Reassignment of *Balanus tintinnabulum maroccana* Broch *Dea B. Beach* 5

Intestinal parasites of the lizard *Lygosoma laterale* *Garnett R. Brooks* 8

Observations on the arboreal snail *Orthalicus floridensis* *Alan K. Craig* 15

Nereid shell blisters in the southern quahog clam *John L. Taylor and Carl H. Saloman* 21

Occurrence of a rare skate in the western North Atlantic *Robbin R. Blackman* 27

First Gulf of Mexico record of *Ranzania laevis* *Robert W. Topp and David L. Girardin* 29

Five-year creel survey of two Florida lakes *Forrest J. Ware, Wesley V. Fish, and Louie Prevatt* 31

The presence of *Hyla squirella* in the Bahamas *Ronald I. Crombie* 49

Additions to the Pleistocene avifauna of Arredondo, Florida *Carl David Frailey* 53

Avifauna of Little Tobago Island *James J. Dinsmore* 55

Birds of the Lluidas Vale (Worthy Park) region, Jamaica *Alexander Cruz* 72

Published August 25, 1972

QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

Editor: Pierce Brodkorb

The Quarterly Journal welcomes original articles containing significant new knowledge, or new interpretation of knowledge, in any field of Science. Articles must not duplicate in any substantial way material that is published elsewhere.

INSTRUCTIONS TO AUTHORS

Rapid, efficient, and economical transmission of knowledge by means of the printed word requires full cooperation between author and editor. Revise copy before submission to insure logical order, conciseness, and clarity.

MANUSCRIPTS should be typed double-space *throughout*, on one side of numbered sheets of 8½ by 11 inch, smooth, bond paper.

A CARBON COPY will facilitate review by referees.

MARGINS should be 1½ inches all around.

TITLES must not exceed 55 characters, including spaces.

FOOTNOTES should be avoided. Give ACKNOWLEDGMENTS in the text and Address in paragraph form following Literature Cited.

LITERATURE CITED follows the text. *Double-space* and follow the form in the current volume. *For articles* give title, journal, volume, and inclusive pages. *For books* give title, publisher, place, and total pages.

TABLES are charged to authors at $25.00 per page or fraction. Titles must be short, but explanatory matter may be given in footnotes. Type each table on a separate sheet, *double-space, unruled,* to fit normal width of page, and place after Literature Cited.

LEGENDS for illustrations should be grouped on a sheet, *double-spaced,* in the form used in the current volume, and placed after Tables. Titles must be short but may be followed by explanatory matter.

ILLUSTRATIONS are charged to authors ($17.00 per page or fraction). DRAWINGS should be in India ink, on good board or drafting paper, and lettered by lettering guide or equivalent. Plan linework and lettering for reduction, so that final width is 4⅛ inches, and final length does not exceed 6⅝ inches. Do not submit illustrations needing reduction by more than one-half. PHOTOGRAPHS should be of good contrast, on glossy paper. Do not write heavily on the backs of photographs.

PROOF must be returned promptly. Leave a forwarding address in case of extended absence.

REPRINTS may be ordered when the author returns corrected proof.

Published by the Florida Academy of Sciences

Printed by the Storter Printing Company

Gainesville, Florida

QUARTERLY JOURNAL
of the
FLORIDA ACADEMY OF SCIENCES

Vol. 35 March, 1972 No. 1

The Armadillidae of Florida (Isopoda, Oniscoidea)

George A. Schultz

Three species of terrestrial isopod crustaceans of the family Armadillidae are present in Florida. *Cubaris murina* Brandt was introduced and *Venezillo evergladensis* Schultz and *V. pisum* (Budde-Lund) are most probably endemic. Schultz (1961) noted the presence of *C. murina* in south Florida and in 1963 he described *V. evergladensis* as new and also from south Florida. In the National Museum of Natural History the author discovered a single gravid female specimen about 5 mm long of *Cubaris pisum* Budde-Lund (1885) (USNM 45605) collected at the mouth of the Indian River (near Jupiter Inlet?). It was collected in March 1874 (by E. Palmer) before the species was actually described by Budde-Lund, and the specimen was identified by Harriet Richardson. Since it was first described it has not been collected again, but the species is included in Van Name's (1936) summary of New World terrestrial isopods along with earlier references to it. The name of the species is now *Venezillo pisum* (Budde-Lund) since the former subgenus *Venezillo* now is considered to be a full genus. The single specimen conforms in morphology to the very general description of Budde-Lund (1885).

Venezillo pisum is briefly redescribed here and comparison is made with the two other species of Armadillidae from Florida. The species has never been illustrated before.

Frontal margin of cephalon slightly raised above tergum of cephalon and broadly rounded in frontal view. About 15 ocelli. Peraeonal segment I only slightly flared with shallow indentation in expanded lateral part of segment. Lateral margin of peraeonal

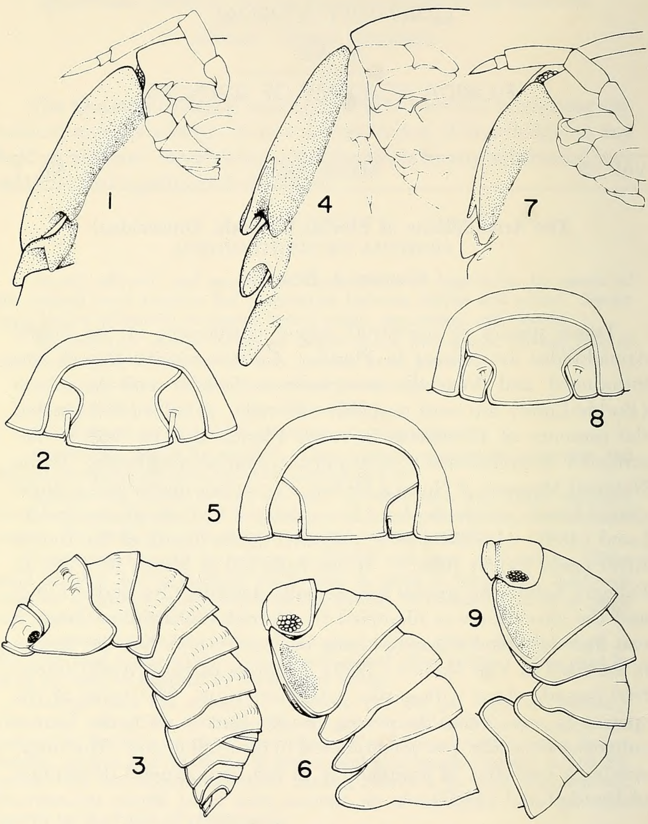


Fig. 1. Armadillidae of Florida. *Cubaris murina* Brandt: 1, ventral view peraeonal segments I and II; 2, pleotelson; 3, lateral view. *Venezillo pisum* (Budde-Lund): 4, ventral view peraeonal segments I, II and III; 5, pleotelson; 6, lateral view anterior part. *Venezillo evergladensis* Schultz: 7, ventral view peraeonal segments I, II and III; 8, pleotelson; 9, lateral view anterior part.

segment I with deep, well defined notch on posterior half of margin. Outside edge of margin (lateral view) higher or more dorsally

located, but extending caudadly more than inside edge (Fig. 6). Peraeonal segment II with large inner notch and peraeonal segment III with very small interior notch (Fig. 4). Posterior margin of pleotelson almost equal in width to width at medial part of pleotelson (Fig. 5).

The placement of the species in Group IIa of Van Name (1936, p. 330) is confirmed. According to Budde-Lund, *V. pisum* is uniformly brown, perhaps reddish brown in color and reaches a length of about 5.5 mm. The specimen described here has no pigment because it has been stored in alcohol for a long time.

The terrestrial isopods of Florida have never been collected on a systematic, widespread, and intensive scale, so many regions of the state never have been explored by carcinologists looking for terrestrial isopods. Whether or not populations of the species still are to be found remains to be seen. The species of the genus *Venezillo* tend to live in the drier habitats when compared to most common terrestrial isopods. They might be living in loose, but not completely dry leaf litter, around the bases of buildings and under refuse which is not subjected to the direct rays of the sun for a long time during the day. The specific habitat preferences of *V. pisum* remain unknown.

Venezillo evergladensis is a relatively small (maximum length about 5.5 mm), gray and white isopod which is abundant around the bases of houses in dense shaded leaf litter. It is abundant in residential Miami and in surrounding suburbs. Schultz (1963) includes a discussion of some ecological aspects of specimens from along the Tamiami Trail in the Everglades.

Cubaris murina is frequently an associate of *V. evergladensis* in leaf litter and around the bases of houses (Schultz, 1961). It at times is also abundant under the loose bark of rotten logs. The species is distinct from both species of *Venezillo* in the nature of the lateral edge of peraeonal segment I (Fig. 1). The specimens have a larger average length than the two species of *Venezillo*, and they are frequently 12 mm long. Specimens are a brick red in color when seen in the field, but change to dark, somewhat reddish brown in alcohol. The following key can be used to distinguish the species:

1a. With notch on posterior part of lateral border of peraeonal segment I 2

1b. With notch inside or below (when viewing ventral aspect of isopod) lateral border of peraeonal segment I (Fig. 1) .... *Cubaris murina* Brandt

2a. Notch deep, well defined and slightly less than one-half length of lateral border of peraeonal segment I (Fig. 4) .... *Venezillo pisum* Budde-Lund

2b. Notch less than one-fourth length of lateral border of peraeonal segment I (Fig. 7) .... *Venezillo evergladensis* Schultz

ACKNOWLEDGMENTS

The author wishes to thank Dr. Thomas E. Bowman of the Division of Crustacea, National Museum of Natural History, Smithsonian Institution for aid in viewing *V. pisum*. He would also like to thank the Theodore Roosevelt Memorial Fund of the American Museum of Natural History for providing a stay at the Smithsonian Institution.

LITERATURE CITED

BUDDE-LUND, G. 1885. Crustacea Isopoda terrestria per familias et genera et species descripta. Copenhagen, pp. 1-319.

SCHULTZ, G. A. 1961. *Cubaris murina* Brandt, an isopod crustacean new to the United States. Crustaceana, vol. 3, No. 2, pp. 169-170.

———. 1963. *Venezillo evergladensis*, a new species of terrestrial isopod crustacean from Florida. Trans. Amer. Micro. Soc., vol. 82, no. 2, pp. 209-213.

VAN NAME, W. G. 1936. The American land and fresh-water isopod Crustacea. Bull. Amer. Mus. Nat. Hist., vol. 71, pp. 1-535.

15 Smith Street, Hampton, New Jersey 08827.

Reassignment of *Balanus tintinnabulum maroccana* Broch

Dea B. Beach

In the process of revising the barnacle subgenus *Megabalanus* Hoek, 1913, specimens from the type lot of *Balanus* (*Megabalanus*) *tintinnabulum maroccana* Broch, 1927, were examined (Figs. 1*a-i*) and were found to possess characters inconsistent with those of the subgenus.

Megabalanus differs from other subgenera of the genus *Balanus* da Costa, 1778, by the possession of well developed radii permeated by pores parallel to the basis. Additionally *B. tintinnabulum tintinnabulum* Linnaeus, the type of the subgenus *Megabalanus*, and other subspecies in the *B. tintinnabulum* complex exhibit 1) radii whose summits are nearly horizontal, 2) a tergal spur that never exceeds one-fourth of the basal margin, 3) a spur furrow that is entirely or partially closed by the infolding of the carinal and scutal sides of the tergum resulting in the elevation of the spur above the inner surface of the valve, and 4) distinct secondary denticulae on both sides of the radial sutural edge.

The radii of *B. maroccana* are not permeated by pores (Fig. 1*i*), and possess oblique summits (Fig. 1*e*). Secondary denticulation is not well developed (Fig. 1*i*). In the description of *B. maroccana*, Broch (1927, p. 21) indicates that the spur is "one third to one half of the greatest diameter of the plate" and that "the spur fasciole is broad and shallow, and never closed . . ." (Figs. 1a-b).

The open spur furrow, the breadth of the tergal spur, the prominence of the adductor ridge, the width of the radii, and the coloration of the shell suggest relationship to the *B. amphitrite* complex. However, it does not appear that *B. maroccana* can be readily identified with any other known member of this complex. It is therefore retained as a distinct species, and is transferred to the subgenus *Balanus*.

Literature Cited

Broch, H. 1927. Studies on Moroccan Cirripeds (Atlantic Coast). Bull. Soc. Sci. Nat. Maroc, vol. 7, pp. 11-38, pls. 1-4, text-figs. 1-10.

Department of Invertebrate Zoology, California Academy of

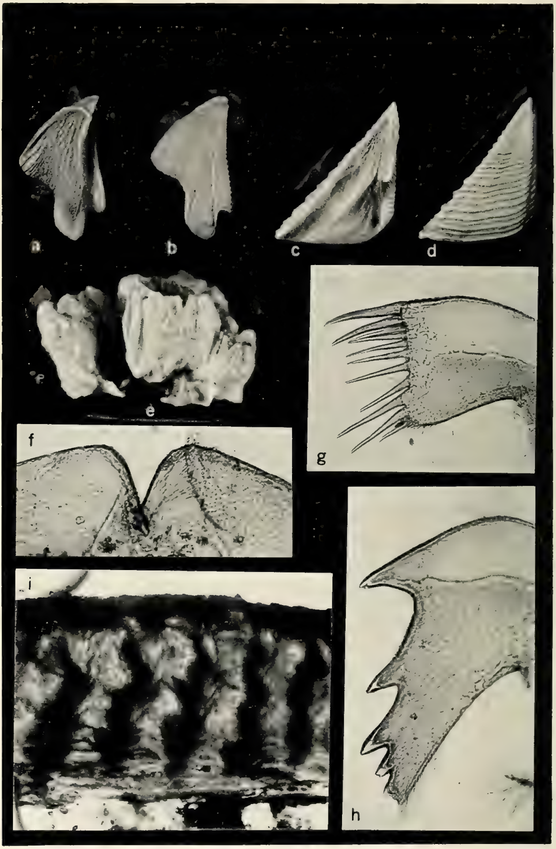


Fig. 1. Shell, opercular valves, and mouth parts of a specimen from the type lot of *Balanus maroccana* Broch: *a,* interior of tergum; *b,* exterior of tergum; *c,* interior of scutum; *d,* exterior of scutum; *e,* external view of shells; *f,* labrum; *g,* maxilla I; *h,* mandible; *i,* thin section of sutural edge of radius; *a-d,* × 7.5; *e,* × 2; *f-i,* × 100.

Sciences, San Francisco, California 94119. Present address: *Program in Environmental Sciences, University of North Carolina at Wilmington, Wilmington, North Carolina 28401.*

Quart. Jour. Florida Acad. Sci. 35(1) 1972

Intestinal Parasites of the Lizard *Lygosoma laterale*

Garnett R. Brooks

The intestinal parasites of *Lygosoma laterale,* the ground skink, have been described by Harwood (1932) and by Byrd (1937). In a later paper, Harwood (1936) correlated the incidence of several parasite species with the type of soil habitat associated with *Lygosoma* near Houston, Texas.

As part of a study on the biology of *Lygosoma* in Florida, data were obtained which relate degree of parasitism with host age, sex, and locality. These data also afford a comparison between two widely separated populations of a single species. Information concerning the food habits and population ecology of *Lygosoma* can be found in Brooks (1963, 1967).

Methods and Materials

Between August, 1960, and April, 1962, 381 skinks, of which 269 were adults, were collected near Gainesville, Florida. Adults are defined as those with a snout-vent length (SVL) of 35 mm or longer; juveniles, as those with a SVL of 34 mm or less. In each individual, the entire digestive tract and the body cavity were examined under a dissecting scope. Parasites were prepared for study following standard procedures. Dr. M. A. Byrd, College of William and Mary, aided me with species identification. Soil descriptions were taken from "Soil Survey: Alachua County, Florida", Series 1940, No. 10, produced by the U.S. Department of Agriculture.

Description of Localities

Five populations of *Lygosoma* were restricted to very localized areas, each of which afforded a sufficiently large sample size to allow a comparison of parasite incidency between sites. None of the localities, however, was uniformly sampled over a year's period. The five localities, their soil types, and their dominant vegetation are described below. At all sites, *Pinus taeda* was the most frequent species of pine and *Quercus laurifolia* and *Q. nigra* the most abundant species of oaks.

Site A. This locality was in the Medicinal Plant Gardens on the

University of Florida campus and contained soil described as Fellowship loamy fine sand. Dominant vegetation consisted of pines and oaks; the herb layer, mainly grasses and sedges, was periodically mowed. A small stream flowed through the center of this site.

Site B. This locality was a cleared, well-drained, park-like area bordered by pine woods. The soil is a complex of Arredondo-Fellowship loamy fine sands. Dominant vegetation consisted of scattered pines and oaks with a herb layer of grasses, sedges, and weeds.

Site C. This site, located in a park-like pasture on a gentle slope, has soil described as Fellowship loamy fine sand which retains moisture and is well suited for pasture grasses. Dominant vegetation consisted of scattered pines, oaks, and hickories, with no understory; pasture grass and weeds comprised the herb layer. A small herd of beef cattle roamed freely through this site.

Side D. This locality consisted of overgrown lawns near two abandoned dwellings, and the adjacent wooded areas. The soil, Kanapaha fine sand which typically has good surface and internal drainage, contained a variable amount of organic material. Scattered pines and oaks, and a mixture of weeds, lawn grass, and sedges at the herb layer constituted the dominant vegetation.

Site E. This site consisted of a small woods and adjacent cleared areas, and contained soil classified as Arredondo loamy fine sand-fine sand complex. The wooded area was a mixed deciduous forest but some clearing of the understory had occurred prior to this study. A small stream flowed through a portion of this site.

RESULTS

Five species of worms were recovered, four of which had been described previously by Harwood (1932). Four of the worms could definitely be identified, a tapeworm, *Cylindrotaenia americana;* a fluke, *Mesocoelium americanum;* and two nematodes, *Physaloptera squamatae* and *Thubunaea leiolopismae.* The fifth worm was an unidentified larval acanthocephalan.

Yamaguti (1959) lists the nematotaeniid tapeworm, *C. americana,* as being found in various anurans (*Bufo, Hyla, Acris, Rana, Pseudacris, Leptodactylus, Scaphiopus,* and *Arthroleptis*), in one genus of salamander (*Desmognathus*), and in *Lygosoma.* Har-

TABLE 1

Percentage of parasitism and mean number of parasites per skink in adult males and females and juvenile *Lygosoma laterale*

Parasite	Adults					Juveniles	Total
	Males		Females		Sub-Total		
	%	Mean	%	Mean	%	%	%
C. americana (CA)	50	—	55	—	53	40	49
M. americanum (MA)	22	6.0	30	5.3	28	25	27
T. leiolopismae (TL)	36	4.2	28	5.2	32	14	27
P. squamatae (PS)	32	2.1	24	2.3	28	6	22
(PS) + (TL)	57	4.0	44	4.7	51	19	42
(CA) + (MA)	10	—	15	—	12	9	11
(MA), (TL) + (PS)	12	—	9	—	10	2	8
(CA), (MA), (TL) + (PS)	4	—	6	—	5	0	3
No Parasite	13	—	11	—	12	33	18
Host sample size	144		125		269	112	381

wood (1932), however, seriously questioned Joyeux's (1924) identification of *C. americana* in the South African frog genus *Arthroleptis*. The number of tapeworms per skink was not determined since they broke into numerous fragments when removed and were unfortunately discarded. All were located in the intestine immediately posterior to the pyloric sphincter.

All of the flukes found could be assigned to *Mesocoelium americanum*. This species was found in two genera of lizards (*Eumeces* and *Lygosoma*) and in a snake (*Storeria*) by Harwood (1932). In adult skinks, the number of flukes ranged from 1-33 (mean = 5.6) and in juveniles from 1-27 (mean = 4.8). In both groups all were found in the intestine immediately posterior to the pyloric sphincter.

The two species of nematodes were both spiruroids. Harwood (1932) lists *Physaloptera squamatae* as being found in *Lygosoma* and in a snake, *Agkistrodon*; *Thubunaea leiolopismae*, in *Lygosoma* and in a frog, *Acris*. Individuals were found mainly within the stomach, esophagus, or encysted on the stomach wall. In a few cases several were found in the intestine or free in the body cavity. In adult skinks, the number of *P. squamatae* ranged from 1-15 (mean = 2.2), that of *T. leiolopismae* from 1-33 (mean = 4.6).

Three larval acanthocephalans were found encysted in the posterior intestine; one in one lizard, two in another.

Table 1 shows the percentage of male and female adult and

TABLE 2
Percentage of parasitism and mean number of parasites per skink in *L. laterale* listed by size group

	Snout-vent length in mm									
	18–25		26–30		31–35		36–40		41–50	
Parasite	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean
C. americana	40	—	43	—	51	—	56	—	49	—
M. americanum	17	1.4	23	5.5	33	5.8	32	5.7	23	5.7
P. squamatae	7	1.0	6	1.7	8	2.5	28	2.2	34	2.4
T. leiolopismae	0	—	9	1.0	20	1.6	22	3.4	47	5.1
P. squamatae + *T. leiolopismae*	7	1.0	15	1.3	29	1.9	42	3.3	65	5.0
No Parasites	47	—	34	—	18	—	15	—	9	—
Age in Months*	0–3		3–6		6–10		9–18		14–42	
Sample size	30		47		49		132		123	

*From Brooks (1967).

juvenile skinks parasitized. Adults have a higher percentage of parasitism in all categories. Although seemingly striking, the percentage differences of parasitism between adult males and females, even in the case of nematodes, are not significant (tapeworms: $\chi^2=0.38$, $P>0.05$; flukes: $\chi^2=1.86$, $P>0.05$; nematodes: $\chi^2=2.38$, $P>0.05$). The probability of an adult skink harboring all three types of worms could be expressed as $0.53\times0.28\times0.51$ or 7.6 per cent (see Table 1), whereas the observed frequency is only 4.5 per cent. Likewise, the expected frequencies of adults harboring tapeworms and flukes, tapeworms and nematodes, and flukes and nematodes could be estimated as 14.8 per cent, 27.0 per cent, and 14.3 per cent respectively. There is no significant difference between the expected and observed values ($\chi^2=2.86$, $P>0.05$).

Table 2 lists the percentage of parasitism for five age groups of *Lygosoma* (age can be estimated by snout-vent length, see Fig. 6 in Brooks, 1967). The incidence of both species of nematodes and the mean number per skink are directly correlated with age; that of tapeworms and flukes are not. Both tapeworm and fluke parasitism decrease slightly in the oldest age group. The number of nonparasitized skinks decreases with increasing age.

The percentages of parasitism for adult skinks from five different localities are given in Table 3. Each locality has a unique distribution of parasite occurrence. The greatest difference appears between Sites C and E, where the difference in fluke incidence is 10× and in nematode incidence, 6×.

TABLE 3
Percentage of parasitism and mean number of parasites per skink in five populations of *L. laterale adults*

	Locality									
	A		B		C		D		E	
Parasite	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean
C. americana	43	—	68	—	76	—	42	—	65	—
M. americanum	41	6.5	18	1.3	66	9.8	16	3.0	6	3.3
T. leiolopismae	39	3.9	18	2.8	0	—	23	2.1	56	5.3
P. squamatae	33	1.4	32	1.4	10	1.7	54	2.3	13	1.3
T. leiolopismae + *P. squamatae*	51	3.9	50	1.9	10	1.7	63	2.7	58	5.5
No parasites	12	—	11	—	3	—	26	—	10	—
Sample size	49		28		29		43		48	

DISCUSSION

Harwood (1932) found several worms, a fluke, *Brachycoelium daviesi,* in 23 per cent, and two nematodes, *Oswaldocruzia pipiens* and *Cosmocercoides dukae,* both in less than 5 per cent of his specimens, that were not identified in Floridian skinks. My results also differ from his in a quantitative manner. For all species in common the incidence of parasitism in Floridian skinks was appreciably higher than in the Texan population.

C. americana was present in 37 per cent of the Texas skinks (Harwood, 1932) and were abundant in skinks living on clay soils but absent from those living on sandy soils (Harwood, 1936). The high incidence of infection (53 per cent) by this worm in Floridian skinks might be explained by habitat differences. All of the Floridian skinks were collected on a substrate of loamy fine sand or fine sand. Harwood (1936) offered no explanation for the correlation between clay soils and incidence of *C. americana,* and since my results are in direct opposition, any explanation must await an understanding of the life history of *C. americana.* If *C. americana* has a direct life cycle as suggested by Joyeux (1924), the major limiting environmental factor night well be moisture content (see below) rather than soil type per se.

Less than 5 per cent of the Texan skinks were parasitized by *M. americanum* (Harwood, 1932) compared to 28 per cent for Floridian skinks. Since the life history of this fluke is unknown, it is not possible to compare intermediate host prevalence and ecology between the two sites. Approximately 10 per cent of 381 skinks from Florida contained pulmonate snails as food items (Brooks, 1963). There are no comparable data for the Texan skinks.

Thubuneae leiolopismae and *Physaloptera squamatae* were found in less than 20 per cent and 4 per cent respectively of Texan skinks (Harwood, 1932). Comparable figures for adult, Floridian skinks were 32 per cent and 28 per cent respectively. Again, it is not feasible to attempt an explanation of these differences since the life histories of these nematodes are not known.

Locality site has a profound effect on the incidence of parasitism (Table 3). The level of parasitism by *C. americana* is the least variable, but a range from 42-76 per cent is significant. These extreme differences between localities, especially in the case of the

fluke and nematodes, emphasizes the importance of local habitat conditions on parasite species abundance.

Since even the smallest skinks have a high level of tapeworm parasitism (Tables 1 and 2), *C. americana* might either have a direct life cycle (see Joyeux, 1924) or a small and relatively common intermediate host(s). *Cylindrotaenia americana* produces proglottids, each containing eight embryos, which exit within fecal pellets. The fecal mass of *Lygosoma* is relatively moist compared with that of other lizards, and mature proglottids can be seen moving on the deposited mass. An interesting question is whether another, or the same skink, would eat these proglottids. Small skinks feed on very small food items and motion is the stimulus which initiates feeding behavior.

LITERATURE CITED

BROOKS, G. R. 1963. Food habits of the ground skink. Quart. Jour. Florida Acad. Sci., vol. 26, pp. 361-367.

———. 1967. Population ecology of the ground skink, *Lygosoma laterale* (Say). Ecol. Monogr., vol. 37, pp. 71-87.

BYRD, E. E. 1937. Observations on the trematode genus *Brachycoelium* Dujardin. Proc. U. S. Nat. Mus., vol. 84, pp. 183-199.

HARWOOD, P. D. 1932. The helminths parasitic in the amphibia and reptilia of Houston, Texas, and vicinity. Proc. U. S. Nat. Mus., vol. 81, pp. 1-71.

———. 1936. The effect of soil types on the helminths parasitic in the ground lizard, *Leiolopisma laterale* (Say). Ecology, vol. 17, pp. 694-698.

JOYEUX, C. 1924. Recherches sur le cycle evolulif des *Cylindrotaenia.* Ann. de Parasitol., vol. 2, pp. 74-81.

YAMAGUTI, S. 1959. Systema helminthum, vol. II. The cestodes of vertebrates. New York, Interscience Publishers..

Department of Biology, College of William and Mary, Williamsburg, Virginia 23185.

Observations on the Arboreal Snail *Orthalicus floridensis*

Alan K. Craig

Interest in the famous tree snails of southern Florida can be traced back at least as far as the relatively early scientific account of De Pourtales (1877). Investigators of the last century were primarily concerned with the zoogeography of *Liguus* and the closely related *Orthalicus* because they believed them to be unusually useful in demonstrating certain aspects of Darwinian evolutionary theory and the processes involved in speciation. These colorful snails were also recruited as evidence to support geological theories regarding genesis of the Florida Keys. Pilsbry (1905, p. 38) suggested that the occurrence of a single species of *Liguus* across a wide range of south Florida islands supported Agassiz's theory that the Florida Keys were merely erosional remnants broken up from what had once been a continuous landmass. This pioneer explanation remained popular until the concept of eustacy became well established.

Simpson seems to be the first to have suggested an alternative explanation for the discontinuity of distribution: namely, that these snails are randomly dispersed throughout southernmost Florida by the action of hurricanes. This scattering of colonies is evident in the comprehensive map prepared by Pilsbry (1912) who showed all known populations of *Liguus* and *Orthalicus* that had been discovered by field workers prior to that date. In this monograph Pilsbry discussed both genera and concluded that *Orthalicus* was less extensive (but perhaps more abundant), being found from Cape Sable to Pavilion Key and in the "southern keys." Today the situation is completely reversed: colonies of *Liguus* have become virtually extinct while *Orthalicus* continues to flourish.

Since both snails belong to the South American family *Bulimulidae* it is apparent they represent faunal elements that have been introduced into Florida from the south. In the case of *Orthalicus* there are species ranging from southern Brazil to northern Mexico. Consequently, we have three possible dispersal routes by means of which this snail or its evolutionary progenitors arrived in Florida.

The least likely explanation involves a spread either naturally or with human assistance from northern Central America across the

southern Gulf Coast region and ultimately into the Florida peninsula. This movement could only have occurred during some interglacial interval of the Pleistocene when the climate was much warmer in winter than at present. It is not at all certain that such conditions actually existed; if they did then we must eliminate the intervening Gulf Coast range and treat the Florida colonies as a relict population. However, no fossil specimens of this genus have been reported from Florida, thus invalidating this dispersal route and the possibility that it evolved locally. *Liguus* is believed to be a very recent (Holocene), recurrent introduction from either Cuba or Hispaniola where related species are widespread. But, lack of an indigenous *Orthalicus* in those localities means that it is very unlikely to have had the same dispersal history. Species from Central America are taxonomically similar to *O. floridensis* and we must conclude that it was transported directly across the Gulf of Mexico to the Florida Keys. The question as to whether this occurred on a single or on multiple occasions (by means of hurricanes) has not been resolved.

The present observations were made in connection with a detailed phytogeographic study of Pavilion Key, southernmost of the Ten Thousand Island group and part of the Everglades National Park. The preliminary comments in this paper relate only to the Pavilion Key population where a comprehensive study by specialists is much needed.

As Pilsbry (1912) shrewdly observed, these snails are basically nocturnal and most active during wet intervals. Prolonged dry weather will induce temporary estivation in *Orthalicus* without formation of the strong mucus seal that is produced in the fall with the onset of cold weather. Their internal distribution on the beach strand vegetation of Pavilion Key suggests these snails are also relatively halophobic. While the island maintains a vigorous population, few specimens can be found on vegetation located along the exposed foreslope of the beach strand where it is subjected to salt spray. No specimens were observed feeding on the leeward mangrove community. The greatest concentration of snails seems to occur on certain preferred food trees at or near the inland boundary of beach strand vegetation where plant density and microclimatic conditions approach the characteristics of a true tropical hammock.

This avoidance of the extreme peri-littoral habitat does not nec-

essarily apply to choice of estivation sites, specimens occasionally having been noted in cavities of storm-killed black mangrove [*Avicennia germinans* (L.) Sterns] that line the western winter beach berm of Pavilion Key. A few snails were noted estivating in exposed positions high above ground in the branches of red mangroves (*Rhizophora mangle* L.) immediately adjacent to the easternmost boundary of beach strand vegetation. It seems likely that these specimens represent snails that were either wind-blown into this habitat or wandered across interlocking upper branches. The diurnal incursion of salty water at high tide makes deliberate migration overland unlikely.

Since the existing literature contains few explicit references to feeding habits of arboreal snails in Florida it may be of interest to note that *Orthalicus* have been observed actively feeding on Florida privet [*Forestiera segregata* (Jacq.) Krug & Urban], Jamaica dogwood [*Piscidia piscipula* (L.) Sarg.], wild papaya (*Carica papaya* L.) [see Fig. 1] white stopper [*Eugenia axillaris* (Sw.) Willd.], and strangler fig (*Ficus aurea* Nutt.) in order of preference. These snails were also observed on African bowstring hemp (*Sansieveria thyrsiflora* Thumb.) key lily (*Hymenocallis keyensis* Small), red mangrove (*Rhizophora mangle* L.), buttonwood (*Con-*

Fig. 1. *Orthalicus* feeding on wild papaya, Pavilion Key.

ocarpus erectus L.) and agave (*Agave decipiens* Baker), but evidence of feeding was not noted.

Some tentative identifications of fungi and algae present on Jamaica dogwood from Pavilion Key have been made in an effort to determine the probable diet of these snails. Applying standard incubation techniques, I.M. Master (research asst., Functional Biology Dept., Rosenstiel School of Marine and Atmospheric Sciences) was able to identify *Fusidium, Zygosporium, Gliocladium, Cladosporium, Macrophoma,* and *Rhizopus* colonies growing on the surface of the branches. From separate cultures transferred to agar plates *Syncephalastrum, Penicillium, Cladosporium, Aspergillus, Streptomyces, Verticillium, Cephalosporium, Fusidium,* and *Phoma* were identified. Most of these fungii are common general saprophytes having a widespread distribution; no predominant fungus was noted on the sample tested.

Thirteen adult specimens of *Orthalicus* were transferred in Oc-

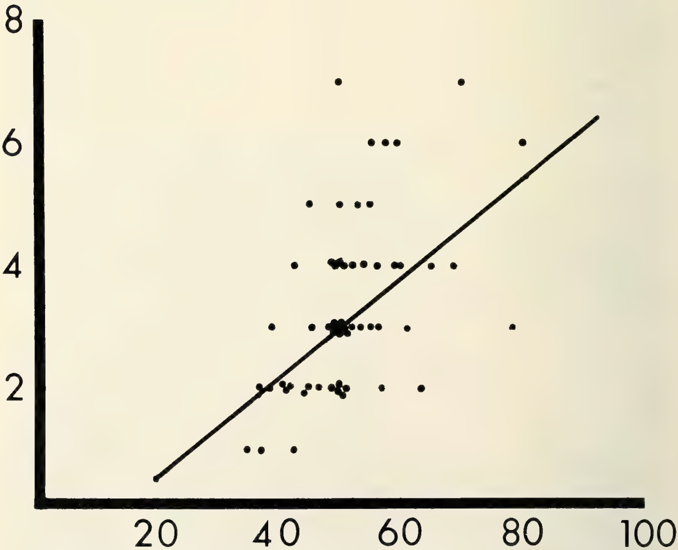


Fig. 2. Scatter diagram; Length (mm)-Age (yrs) for *Orthalicus floridensis*.

tober from Pavilion Key to a latitudinally equivalent location on the east coast of Florida where they were released on a variety of exotic ornamentals. The majority escaped within 48 hours but several that remained on ylang-ylang (*Cananga odorata* Hook. f. & Thoms.) for longer periods were observed to feed sporadically although no macro-epiphytic flora was apparent. Better results were obtained by placing the snails on banana plants (*Musa sapientum*) where they ingested the cutin layer of petioles. This diet was evidently not entirely acceptable as 11 specimens eventually relocated themselves on two mature cultivated papaya trees whose trunk surfaces supported a flourishing algae mat. In slightly less than 14 days the snails completely removed all visible trace of algae from the host trees. They then began to disperse across a residential grass lawn (treated with herbicides and insecticides) and were all found dead within a few meters of the trees.

A statistical age-growth study was made from a representative sample of dead shells collected at various points on Pavilion Key. The results are shown on the scatter diagram (Fig. 2) which indicates a mean age of 3.36 years and a corresponding length of 51.6 mm. The largest specimen collected measured an impressive 92 mm by 48 mm making it perhaps the largest indigenous terrestrial snail ever recorded from the United States and one of the largest arboreal snails found anywhere in the world. This exceptional specimen was so faded that no variceal age estimate could be made. If each major dark brown variceal does in fact correspond to a winter estivation period, then the maximum age noted among the sample specimens was 7. However, any analysis based on these markings may be affected by intermittent markings induced from temporary estivation during dry spells. If the more prominent variceals correspond to a winter estivation instead of being continuously deposited and resorbed, then all specimens in the sample died during a winter season. This suggests *Orthalicus* is particularly sensitive to cold. Every empty shell examined was intact without indications of crushing or breaking by crabs or other predators (Rhoads, 1899, p. 45).

The absence of *Orthalicus* colonies in the less accessible areas of the heavily urbanized Florida east coast is probably related to the lack of a suitable forage habitat. Their introduction into the few remaining stands of hammock vegetation is recommended where

specimens of preferred food trees are present. A program of careful redistribution would disperse the population and help insure survival by reducing the possibility of extinction through destruction of the few remaining colonies.

LITERATURE CITED

DEPOURTALES, L. F. 1877. Hints on the origin of the flora and fauna of the Florida Keys. Amer. Naturalist, vol. 11, pp. 137-144.

PILSBRY, HENRY A. 1905. Land shells of the Florida Keys. The Nautilus, vol. 19, 37-41.

———. 1912. A study of the variation and zoogeography of *Liguus* in Florida. Jour. Acad. Nat. Sci. Philadelphia, vol. 15, pp. 429-471.

RHOADS, SAMUEL N. 1899. Annotated list of land and fresh-water shells recently collected in the vicinity of Miami, Florida. The Nautilus, vol. 13, pp. 43-48.

Department of Geography, Florida Atlantic University, Boca Raton, Florida 33432.

Nereid Shell Blisters in the Southern Quahog Clam

John L. Taylor and Carl H. Saloman

The nereid polychaete, *Neanthes arenaceodentata* Moore = *Neanthes caudata* (della Chiaje), is the apparent cause of shell blisters discovered in a population of the quahog clam, *Mercenaria campechiensis* Gmelin, sampled in Boca Ciega Bay, Florida. Thus far, nereid blisters have not been reported in quahogs from other areas of Tampa Bay or in other coastal regions of the United States. The worm-inhabited blisters were similar in appearance to scallop blisters caused by the nereid *Ceratonereis tridentata* (Webster), but different in appearance from blisters in hard clams caused by the spionid *Polydora ciliata* (Wells, 1965; Landers, 1967). Additional reports on biogenous disfiguration of shells include those by Wells and Wells (1962); Wells, Wells, and Gray (1964); Davis (1967; Blake (1969); Evans (1969); Haigler (1969); and Jones (1969).

Blister Incidence, Location, and Damage

Shell blisters in Boca Ciega Bay quahogs were discovered in a sample of living clams collected near the island of Tierra Verde on December 9, 1968 (Fig. 1). The clams in that locality were six years old and had the following average shell dimensions: length, 100.8 mm; height, 95.3 mm; width, 57.7 mm (Taylor and Saloman, 1970). During the following 16 months, monthly samples of at least 100 living clams were taken. Incidence of blisters in that period averaged 37 per cent and ranged from 30 per cent (March and October, 1969) to 51 per cent (December 1969). Among empty shells randomly collected in the same vicinity, a 44 per cent incidence of blister damage was also noted. Live worms were collected only from living shells, parasitism or another benefit to the worm from some activity or function of the clam is indicated.

Shell blisters in 91 per cent of the clams were found on one valve only, at the posterior end. Nine per cent of the quahogs had blisters on both valves. Up to one-half of the inner shell surface was raised by well-developed blisters, and in some clams the pos-

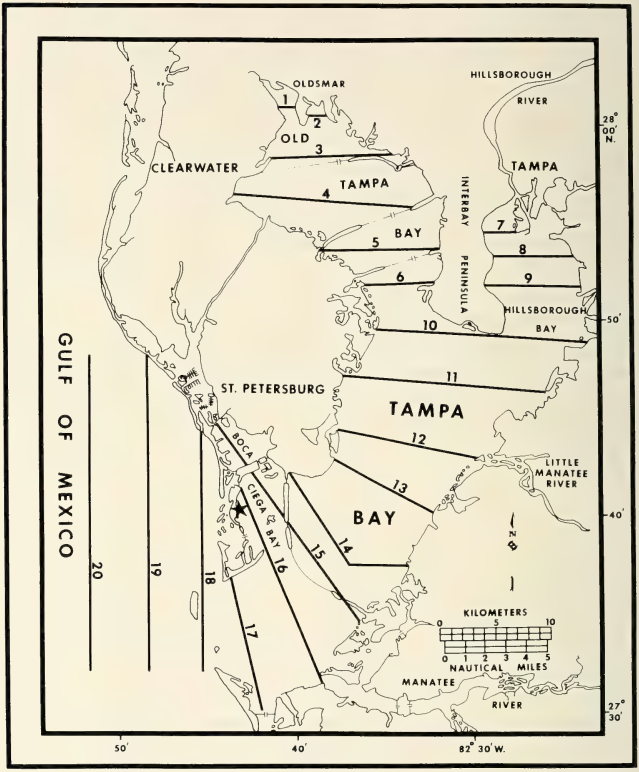


Fig. 1. Sampling transects of a benthic survey in Tampa Bay, Florida. The star indicates the location of a bed of quahog clams (*Mercenaria campechiensis*) infested with a nereid polychaete (*Neanthes arenaceodentata*) found in shell blisters.

terior adductor and retractor muscles were partially destroyed (Figs. 2 and 3). Density of worms in the sediment of the infected clam bed was about 128 worms per m^2, computed from the number of animals in five substrate samples obtained with a plug sampler (Taylor and Saloman, 1969a).

Fig. 2. Damage from a shell blister containing the nereid polychaete (*Neanthes arenaceodentata*) in the quahog clam (*Mercenaria campechiensis*) collected in Boca Bay, Florida.

ECOLOGY OF THE WORM

Neanthes arenaceodentata has been reported from shallow water in temperate to tropical seas around the world. It inhabits floating masses of algae, crevices, and interstices among rocks, shells, fouling organisms, and sediments of sand or mud. Its diet consists mainly of algae, but may include small animals (Pettibone, 1963; Hartman, 1968). To our knowledge, *N. arenaceodentata* has never been reported in shell blisters.

Results of a benthic survey (Taylor, 1966) in which *N. arenaceodentata* was collected at 72 stations in Boca Ciega Bay and portions of Tampa Bay, substantiate previous observations on the

Fig. 3. Tissue damage to the posterior adductor and retractor muscles (tip of arrow) of a quahog clam (*Mercenaria campechiensis*) from Boca Ciega Bay, Florida, at the margin of a shell blister containing the nereid polychaete (*Neanthes arenaceodentata*).

worm's habitat. At more than one-half of the stations inhabited by the worm, the bottom was covered with sea grasses and attached algae. Average sediment particle size was 2.6 phi (fine sand), and the average shell (calcium carbonate) composition by weight was 10.3 per cent (Taylor and Saloman, 1969b).

N. arenaceodentata was caught mainly in relatively high salinity water in Tampa Bay. About 91 per cent of its occurrences were seaward of transect 13 (Fig. 1), where average annual salinity exceeds 25 ppt. All collections containing more than 100 worms per sample from a 14.2 liter bucket dredge (Taylor, 1965) came from the shallow vegetated bottom of Boca Ciega Bay where salinity normally exceeds 30 ppt (Taylor and Saloman, 1969b).

In northern waters, the upper size limit of *N. arenaceodentata* is about 70 mm long by 4 mm wide (Pettibone, 1963). The largest specimen collected in our survey was 30 by 4 mm, and the largest found inside a shell blister was 20 by 1 mm. Worms longer than 15 mm were sexually mature, and gravid individuals were collected in February, April, May, September, and November. Water tem-

peratures during those months range between 9-31 C, and it seems likely that the worm breeds in every month of the year. Year-round breeding in subtropical waters has been found in a number of other polychaete species in Biscayne Bay, Florida (McNulty and Lopez, 1969).

No epitokous state has been reported for *N. arenaceodentata*, and females produce from 143-791 young. The embryos are incubated by the male for about 21 days, and during that time there is a strong male-male and male-female fighting reaction. Embryos are unciliated and do not pass through a pelagic stage. The young reach sexual maturity in about two months, and males may reproduce more than once. Females are either eaten by the males or die after spawning (Reish, 1957).

SHELL BLISTERS AND QUAHOG FISHERIES

The shell blisters containing *N. arenaceodentata* consisted of a raised conchiolin membrane, which is produced by the clam and separates the worm from the mantle cavity. In the blister cavity, the worm accumulates fecal material and detritus, which gives the blister a dark and unattractive appearance. Such a conspicuous abnormality makes infested individuals unacceptable for commerce in half-shell and steamer clams. Furthermore, blister formation probably impairs the vitality of the host, and in well-developed blisters, damage to soft tissues may cause clam mortality. Consequently, recreational and commercial quahog fishermen should regard *N. arenaceodentata* as a possible threat to hard clam fisheries and report clams containing blisters to local or Federal conservation agencies.

LITERATURE CITED

BLAKE, J. A. 1969. Systematics and ecology of shell-boring polychaetes from New England. Amer. Zool., vol. 9, no. 3, ed. 2, pp. 813-820.

DAVIS, J. D. 1967. *Polydora* infestation of Artic wedge clams: a pattern of selective attack. Proc. Nat. Shellfish Assn., vol. 57, pp. 67-72.

———. 1969. *Polydora* infestation of *Mercenaria mercenaria*. Nautilus, vol. 83, no. 2, p. 74.

EVANS, J. W. 1969. Borers in the shell of the sea scallop, *Placopecten magellanicus*. Amer. Zool., vol. 9, no. 3, ed. 2, pp. 775-782.

HAIGLER, S. A. 1969. Boring mechanism of *Polydora websteri* inhabiting *Crassostrea virginica*. Amer. Zool., vol. 9, no. 3, ed. 2, pp. 821-828.

HARTMAN, O. 1968. Atlas of the errantiate polychaetous annelids from California. Allan Hancock Found., Univ. of Southern California, Los Angeles, 828 pp.

JONES, M. L. 1969. Boring of shell by *Caobangia* in freshwater snails of southeast Asia. Amer. Zool., vol. 9, no. 3, ed. 2, pp. 829, 835.

LANDERS, W. S. 1967. Infestation of the hard clam, *Mercenaria mercenaria*, by the boring polychaete worm, *Polydora ciliata*. Proc. Nat. Shellfish Assn., vol. 57, pp. 63-66.

MCNULTY, J. K., AND N. N. LOPEZ. 1969. Year-round production of ripe gametes by benthic polychaetes in Biscayne Bay, Florida. Bull. Mar. Sci., vol. 19, no. 4, pp. 945-954.

PETTIBONE, M. H. 1963. Marine polychaete worms of the New England region. 1. Aphroditidae through Trochochaetidae. U.S. Nat. Mus. Bull. 227, pt. 1, v.+356 pp.

REISH, D. J. 1957. The life history of the polychaetous annelid *Neanthes caudata* (della Chiaje), including a summary of development in the family Nereidae. Pac. Sci., vol. 11, pp. 216-228.

TAYLOR, J. L. 1965. Bottom samplers for estuarine research. Chesapeake Sci., vol. 6, no. 4, pp. 233-234.

———. 1966. Benthic project. *In* J. E. Sykes, editor, Report of the Bureau of Commercial Fisheries Biological Station, St. Petersburg Beach, Florida, Fiscal Years 1962-1964. U. S. Fish Wildl. Serv., Circ. no. 239. pp. 5-8.

TAYLOR, J. L., AND C. H. SALOMON. 1969a. Benthic project. *In* J. E. Sykes, editor, Report of the Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Florida, Fiscal Year 1968. U. S. Fish Wildl. Serv., Circ. no. 313, pp. 3-10.

———. 1969b. Sediments, oceanographic observations, and floristic data from Tampa Bay, Florida, and adjacent waters, 1961-65. U. S. Fish Wildl. Serv., Data Report no. 34, 561 pp. on 9 microfiche.

———. 1970. Benthic project. *In* J. E. Sykes, editor, Report of the Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Florida, Fiscal Year 1969. U. S. Fish Wildl. Serv., Circ. no. 342, pp. 3-10.

WELLS, H. W. 1965. Nereid blisters in Florida scallops. Quart. Jour. Florida Acad. Sci., vol. 28, no. 1, pp. 123-128.

WELLS, H. W., AND M. J. WELLS. 1962. The polychaete *Ceratonereis tridentata* as a pest of the scallop *Aequipecten gibbus*. Biol. Bull., vol. 122, no. 1, pp. 149-159.

WELLS, H. W., M. J. WELLS, AND I. E. GRAY. 1964. The calico scallop community in North Carolina. Bull. Mar. Sci. Gulf Caribbean, vol. 14, no. 4, pp. 561-593.

National Marine Fisheries Service Biological Laboratory, 75 - 33rd Avenue, St. Petersburg Beach, Florida 33706.

Quart. Jour. Florida Acad. Sci. 35(1) 1972.

Occurrence of a Rare Skate in the Western North Atlantic

Robbin R. Blackman

Captures of *Dactylobatus armatus* Bean and Weed (1909), a bizarre skate and only known member of its genus, have previously been limited to five specimens. The original account was based on two syntypes, an immature male, 278 mm total length (TL), USNM 62914, Albatross Sta. 2624, 32°36′ N, 77°29′ W, 472 meters; and a female, 264 mm TL, USNM 62915, Albatross Sta. 2666, 30°47′30″ N, 79°49′ W, 494 meters. Bigelow and Schroeder (1953) gave a detailed description of Bean and Weed's immature male. The next reported captures (Bigelow and Schroeder, 1965) were two females, one 316 mm TL, MCZ 42474, Silver Bay Sta. 3095, 28°23′ N, 79°49′ W, 338-348 meters; and the other, 250 mm TL, MCZ 43073, Silver Bay Sta. 3726, 29°42′ N, 80°10′ W, 338-348 meters. Recently, they (1968) reported another male, 263 mm TL, MCZ 45883, Oregon Sta. 5753, 29°29′ N, 79°53′ W, 667-695 meters.

This report adds six additional specimens collected from 1960-1965 by the U. S. Fish and Wildlife Service exploratory fishing vessels *Silver Bay* and *Oregon I.* Available data are one female, 300 mm TL, Silver Bay Sta. 2074, 29°43′ N, 80°07′30″ W, 366-369 meters; two specimens, sex unknown, one 290 mm, the others length unknown, Silver Bay Sta. 3095, 28°23′ N, 79°49′ W, 338-347 meters; one female, 662 mm TL, USNM 202499, Silver Bay Sta. 5483, 27°40′30°′ N, 79°48′ W, 371-366 meters; one specimen, sex and length unknown, Oregon Sta. 5232, 29°59′30°′ N, 80°08′ W, 384-402 meters; and one specimen, sex and length unknown, Oregon Sta. 5265, 29°13′ N, 79°56′ W, 549 meters, now UF 12951, ♀, 184.2 TL, 300 fms.

Of the eleven specimens known, nine were captured between Vero Beach and St. Augustine, Florida in 338-695 meters, one off Georgia in 494 meters, and one off Charleston, South Carolina in 472 meters. The six specimens reported here do not extend the known range of the species.

The largest female (662 mm) is twice as long as the largest specimen previously reported (316 mm). Measurements comparable to those made by Bean and Weed (1909) and Bigelow and Schroeder (1953) revealed no significant differences in body pro-

portions or other morphological characteristics. The reproductive system of this large female resembled that of nearly mature developmental stages of *Raja erinacea* described by Richards, Merriman and Calhoun (1963). The uterus, oviduct, and shell glands were well developed, and the ovaries contained small pale globules. The apparent near maturity of this 662 mm specimen indicates that *Dactylobatus armatus* is one of the moderately large skates.

LITERATURE CITED

BEAN, B. A., AND A. C. WEED. 1909. Description of a new skate (*Dactylobatus armatus*) from deep water off the southern Atlantic coast of the United States. Proc. U. S. Nat. Mus., vol. 36, pp. 459-461.

BIGELOW, H. B., AND W. C. SCHROEDER. 1953. Fishes of the western North Atlantic. Mem. Sears Found. for Marine Res., no. 1 part 2, pp. 323-327.

———. 1965. A further account of batoid fishes from the western Atlantic. Bull. Mus. Comp. Zool., Harvard, vol. 132, no. 5, pp. 465-467.

———. 1965. New records of two geographically restricted species of western Atlantic skates: *Breviraja yucatanensis* and *Dactylobatus armatus*. Copeia, 1968, no. 3, pp. 630-631.

RICHARDS, S. W., D. MERRIMAN, AND L. H. CALHOUN. 1963. Studies on the marine resources of southern New England IX. The biology of the little skate, *Raja erinacea* Mitchill., Bull. Bingham Oceanographic Collection, vol. 18, Article 3, pp. 15-18.

U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, St. Simons Island, Georgia 31522. Present address: *U. S. Army Corps of Engineers, Jacksonville District, P. O. Box 4970, Jacksonville, Florida 32201.*

Quart. Jour. Florida Acad. Sci. 35(1) 1972

First Gulf of Mexico record of *Ranzania laevis*

ROBERT W. TOPP AND DAVID L. GIRARDIN

A LARGE specimen of the molid fish, *Ranzania laevis* (Pennant), was caught in February 1967 by Mr. Ray Thornton, a commercial fisherman, who hand-captured it in the surf two miles north of Little Marco Pass, Florida (26°02′N; 81°46′W). The specimen, in excellent condition, has been accessioned into the Florida Department of Natural Resources collections (FSBC 4681). Data for the specimen are as follows: total length 671 mm; length from snout to upper posterior point of body, excluding clavus 611 mm, including clavus 648 mm; greatest body depth 334 mm; predorsal length 548 mm; length of dorsal base 86 mm; preanal length 572 mm; length of anal base 73 mm; length of pectoral fin 118 mm; head length 232 mm; snout length 86 mm; postorbital length of head 115 mm; length of orbit 32 mm; basal elements in clavus 19; branched rays of clavus 19; dorsal rays 19; anal rays 19; pectoral rays 13; vertebrae 18; weight at capture 10 kg.

Since *R. laevis* apparently does not exceed a length of 800 mm (Fraser-Brunner, 1951, p. 98), we judge our specimen to be an adult. Gonads, however, were macroscopically indistinguishable.

Robins (1966) reviewed western Atlantic records of *R. laevis*, and described a specimen, presumably a juvenile, obtained from off Palm Beach, Florida, representing the first record from Atlantic waters of the United States. Of the four molid species known from Florida, three have now been reported from the Gulf of Mexico. Dawson (1965) summarized published records of *Mola mola* (Linnaeus) and *Masturus lanceolatus* (Liénard) from the Gulf, and added new records of each. The example herein described, representing the third species, constitutes the first record from the Gulf of Mexico and the first adult from waters adjacent to the eastern United States.

We thank Mr. Leon Kenney, President of Pinellas Seafood, St. Petersburg, for donating the specimen, and Mrs. Rita M. Moore of the Suncoast Medical Clinic, St. Petersburg, for providing radiographs.

LITERATURE CITED

DAWSON, C. E. 1965. Records of two headfishes (family Molidae) from the north-central Gulf of Mexico. Proc. Louisiana Acad. Sci., vol. 28, pp. 86-89, 2 figs.

FRASER-BRUNNER, A. 1951. The ocean sunfishes (family Molidae). Bull. Brit. Mus. (Nat. Hist.), Zool., vol. 1, no. 6, pp. 89-121, 18 figs.

ROBINS, C. RICHARD. 1966. The molid fish *Ranzania laevis* in the western Atlantic. Quart. Jour. Florida Acad. Sci., vol. 29, no. 4, pp. 287-289.

Florida Department of Natural Resources Marine Research Laboratory, St. Petersburg, Florida 33731. Contribution No. 145.

Quart. Jour. Florida Acad. Sci. 35(1) 1972

Five-Year Creel Survey of Two Florida Lakes

Forrest J. Ware, Wesley V. Fish, and Louie Prevatt

Lakes Griffin and Harris, with surface acreages of 9,100 and 16,500 respectively, were the study areas selected for this project. Located in central Florida near the city of Leesburg, these natural lakes provide a popular recreation area for this section of the State. Historically, Griffin and Harris enjoyed excellent reputations for their sport fisheries, but in recent years considerable local criticism has developed concerning fisheries quality, especially in Lake Griffin. Both lakes are showing signs of environmental degradation from cultural eutrophication and can be considered eutrophic. Present conditions are characterized by turbid waters supporting dense blue-green algal populations, extensive bottom muds, and large carrying capacities for fishes. Of the two lakes, Griffin is considered more advanced in its eutrophic state.

During 1966 a creel survey of the present design was implemented to document existing fisheries and monitor changes or trends through time. The survey provided for seasonal and annual estimates of fishing pressure, catch composition, and fishing success. Results have been compiled and analyzed for the past five years. The purpose of this paper is to present these findings, documenting the fisheries quality of two Florida lakes and discuss aspects of the creel design.

Creel Method

The Griffin and Harris creel program evolved from a randomized systematic creel census that was employed by our agency during the early Sixties. By 1964, certain limitations were realized and a more efficient program sought. Dr. Don W. Hayne, Institute of Statistics, North Carolina State University, was contacted for consultation, and, working with Mr. James P. Clugston of the Commission, he designed the stratified creel survey with non-uniform probability sampling currently in use. The design was computerized by the Cooperative Statistical Unit and now serves as a model for creel surveys in other Southeastern States.

Stratification of the roving creel survey involves the designation

of areas within lakes, periods of time, and kinds of days (weekday or weekend day). Within each time stratum samples are selected randomly and with non-uniform probabilities, which are proportional to the predicted daily patterns of fishing activity (determined by prior study). Both stratification and unequal probabilities are imposed to reduce the variance of estimates below those which would occur if simple random sampling were used. In a practical sense the area stratification facilitates implementation of the survey over large areas of the lake and allows for separate area estimates. Sampling in time, with non-uniform probability based on fishing activity, ensures that most of the creel clerk's effort will coincide with most of the fishing activity. The basic value of the non-uniform probability sampling scheme is discussed by Pfeiffer (1966).

Creel sampling schedule was set up on a basis of two-week periods the year around. Within each period five days were scheduled for sampling each lake by random selection and included at least one weekend day. This allowed for 10 work-days and four off-days per sample period. Each sample day was also divided into two periods; 7:00 AM-1:00 PM and 1:00 PM-7:00 PM in order to include the entire day. The non-uniform probabilities were then assigned to each sample period within a day and according to the type of day (weekend or weekday). Because of their large size, Lakes Griffin and Harris were separated into six approximately equal areas (Figs. 6 and 7). This facilitated the collection of data by requiring the clerk to spend one hour in each area and provided for separate area estimates (not presented here).

Creel data were transferred to I.B.M. cards and shipped to North Carolina State University, where estimates were calculated on the I.B.M. 360 System Computer, Model 75. Dr. Robert E. Mason, Assistant Statistician, North Carolina State University, was responsible for computer processing. He also served as primary consultant concerning the mechanics of the design.

One characteristic of our creel survey, often not found in others, is the measurement of fishing success by species effort. It is believed that such information provides a more accurate estimate of the fishery quality for a species. In practice, only those fishermen determined (by interview) to be fishing for a particular fish were used in the estimate calculation of success for that species. This accomplishes a measurement of the catch rate of bass, for example,

TABLE 1

Estimate precision for lakes Griffin and Harris creel survey

Year and Lake	Criteria	Estimate	Approximate SD	Per Cent SD of the Mean
1966–1967				
Lake Griffin	Total Pressure	255,090	26,529	10.4
Lake Griffin	Total Catch	238,620	65,620	27.5
Lake Harris	Total Pressure	230,838	24,469	10.6
Lake Harris	Total Catch	202,710	48,042	23.7
1967–1968				
Lake Griffin	Total Pressure	240,246	32,546	13.5
Lake Griffin	Total Catch	219,018	40,028	18.3
Lake Harris	Total Pressure	175,944	16,715	9.5
Lake Harris	Total Catch	125,994	30,994	24.6
1968–1969				
Lake Griffin	Total Pressure	327,066	50,041	15.3
Lake Griffin	Total Catch	300,942	61,091	20.3
Lake Harris	Total Pressure	180,444	23,870	13.2
Lake Harris	Total Catch	166,248	48,361	29.1
1969–1970				
Lake Griffin	Total Pressure	265,890	54,175	20.4
Lake Griffin	Total Catch	270,744	88,330	32.6
Lake Harris	Total Pressure	199,238	24,646	12.4
Lake Harris	Total Catch	180,600	38,480	21.3
1970–1971				
Lake Griffin	Total Pressure	230,498	27,579	12.0
Lake Griffin	Total Catch	222,892	75,494	33.9
Lake Harris	Total Pressure	244,720	25,293	10.3
Lake Harris	Total Catch	330,574	88,255	26.7

by bass fishermen and excludes other incidental catches of bass. However, there are periods when estimates cannot be made by the computer program in this manner. This occurs when there are no records of fishing for a particular species or when catches are incidental to fishing for other fishes. Mr. D. E. Holcomb of the Commission implemented this modification in creel design during the 1967 creel year.

Computer output for our program provides estimates of fishing pressure, both total and species-directed pressure in man-hours, total numerical catch by species, and fishing success (number of

fish per man-hour of effort). Two important limitations of the data are recognized; there is no estimation for weight of fish harvested or of man-day use. Both of these criteria could be answered by additional sampling, but this was not done in this study.

Another useful element of the computer output is the value of "approximate standard deviation" (usually called standard error) that is provided for each summary estimate. This gives an approximate plus or minus value as an estimate of precision. It should be understood however, that an exact confidence interval cannot be computed for these figures because the underlying distribution of the estimates is not normally distributed (Dr. Don W. Hayne, personal communication). Examples of the precision of estimates obtained in this study are provided in Table 1.

Findings

The principal fishes sought-after by sport fishermen at lakes Griffin and Harris were largemouth bass (*Micropterus salmoides*),

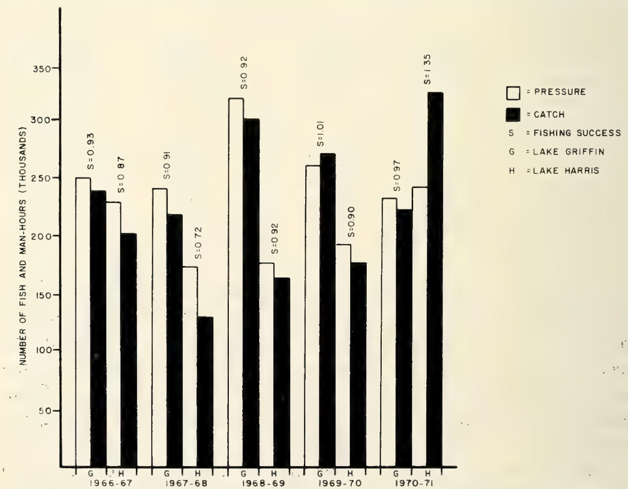


Fig. 1. Estimated fishing pressure, catch, and fishing success for lakes Griffin and Harris, 1966-1971.

black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), and redear sunfish (*Lepomis microlophus*). For the purpose of collecting creel data bluegill and redear were recorded in aggregate and categorized as "bream". Catfish species were also reported as a composite since they constituted a relatively minor portion of the fisheries. Species of Ictaluridae included channel catfish, (*Ictalurus punctatus*), white catfish (*I. catus*), brown bullhead (*I. nebulosus*), and yellow bullhead (*I. natalis*).

Fishing Pressure and Catch. Annual estimates of fishing pressure, catch, and success for the five year period (1966-71) on Lakes Griffin and Harris are shown in Fig. 1. In general, the data show a positive correlation between fishing pressure and catch, as pressure was increased the catch also increased.

Fishing pressure was higher on Lake Griffin for all years except 1970-71. Range in annual pressure was from an estimated low of 230,498 man-hours in 1970-71 to a high of 327,066 man-hours during 1968-69 (Fig. 1). Calculations of fishing pressure on a per acre basis varied from 25.3 man-hours per year to 34.9 man-hours per year.

Annual catch from Griffin was correspondingly higher for all years but 1970-71. Catch varied from an estimated low of 219,018 fishes in 1967-68 to a high of 300,942 fishes in 1968-69 (Fig. 1). Annual harvest per acre ranged from 24.5 to 33.2 fishes.

Fishing pressure and catch for Lake Harris, the larger lake, ranged from an estimated low in 1967-68 of 175,944 man-hours of fishing and a catch of 125,994 fishes, to a high in 1970-71 of 244,720 man-hours fishing and a catch of 330,574 fishes; the highest yield for either lake during the study period (Fig. 1). Calculated on a per acre basis, exploitation of the fishery resource by sport fishing was relatively minor in Harris, ranging from 7.6-20 fishes per year. Fishing pressure per acre varied from 10.7-14.8 man-hours per year.

Lake Griffin Catch Composition and Fishing Pressure by Species. The data in Fig. 2 illustrate fishing pressure directed at each species and estimated composition of the catch over the five year period. These data show that the sport fishery of Lake Griffin was sustained largely by panfishes.

Black crappie was the most sought-after species by sport fishermen, sustaining 42.7 per cent of the estimated total pressure over a four year period (species fishing pressure was not determined dur-

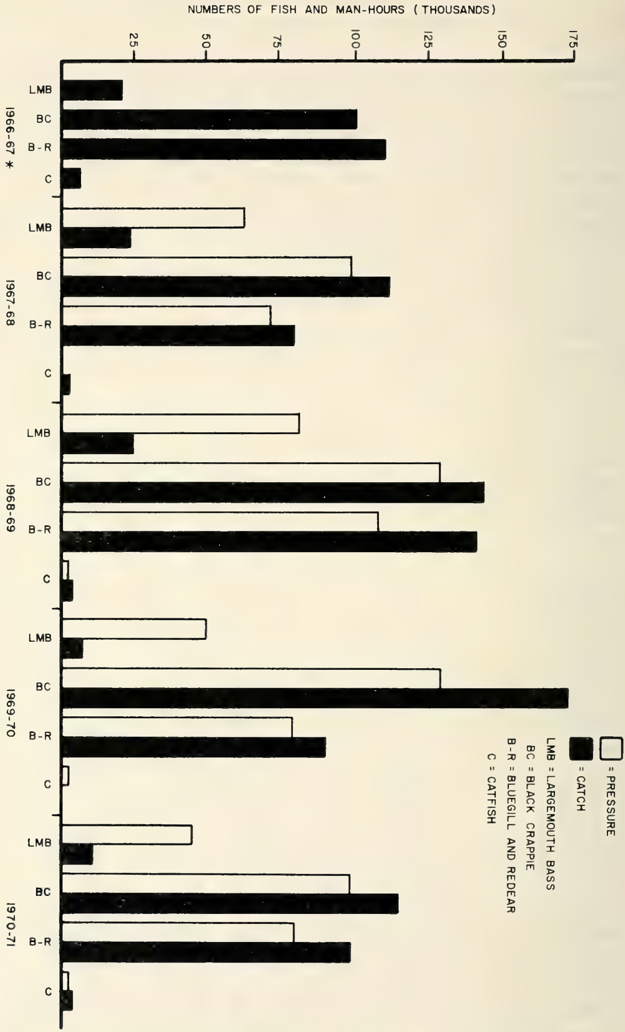


Fig. 2. Estimated fishing pressure by species and catch composition of Lake Griffin, 1966-1971. *Pressure by species not available.

ing the first creel year 1966-67). Annual estimates of pressure for crappie varied from 98,778-130,374 man-hours (Fig. 2). Similarly, crappie accounted for over one-half the estimated total catch (51.2 per cent) for the creel period. The highest annual yield of this species was 173,112 fishes during 1970-71 (19 fish/acre), and crappie composed 63.9 per cent of the total catch for that year. According to our creel clerk the estimated average size black crappie taken from Griffin is 12 ounces.

Bluegill and redear, categorized as "bream", ranked second in fishermen's choice at Lake Griffin, based on man-hours of effort expended by fishermen. The four year summary indicated 32.4 per cent of the total pressure was for these species. Annual fishing pressure estimates for "bream" ranged from 72,192-110,742 man-hours, while annual catches varied from 88,644-137,358 fishes (Fig. 2). "Bream" comprised 41 per cent of the total catch for the five year period. Average weight of these species in Griffin is reported at 8 ounces.

Almost one-fourth of the total fishing pressure (23 per cent) was directed toward largemouth bass. Yet, this species provided only 6.4 per cent of the total catch during the period of study. Available evidence suggests the fishery is declining. In the first three creel years, the catch of largemouth bass varied between an estimated 19,434-23,772 fish and composed between 7.9 per cent and 9.4 per cent of the total catch, whereas in the last two years, the catch dropped to 7,374 fish and 9,371 fish, a composition of 2.7 per cent and 4.2 per cent of the total catch respectively (Fig. 2). Fishing pressure for bass also declined from a high of 82,380 man-hours in 1968-69 to a low of 47,684 man-hours in 1970-71. However, the pressure drop was not proportional to the decrease in catch (Fig. 2). Observations indicated the average creel-size bass was approximately 2 pounds.

Catfish comprised a minor portion of the Griffin sport fishery. Total fishing pressure for these species amounts to less than one per cent for any creel year. Highest annual catch was estimated at 5,994 fish, a composition of 2.5 per cent (Fig. 2).

Lake Harris Catch Composition and Fishing Pressure by Species. Fig. 3 shows the estimated fishing pressure for each species and catch composition for Lake Harris during the five year study. Several differences appear when comparing the Harris fishery with

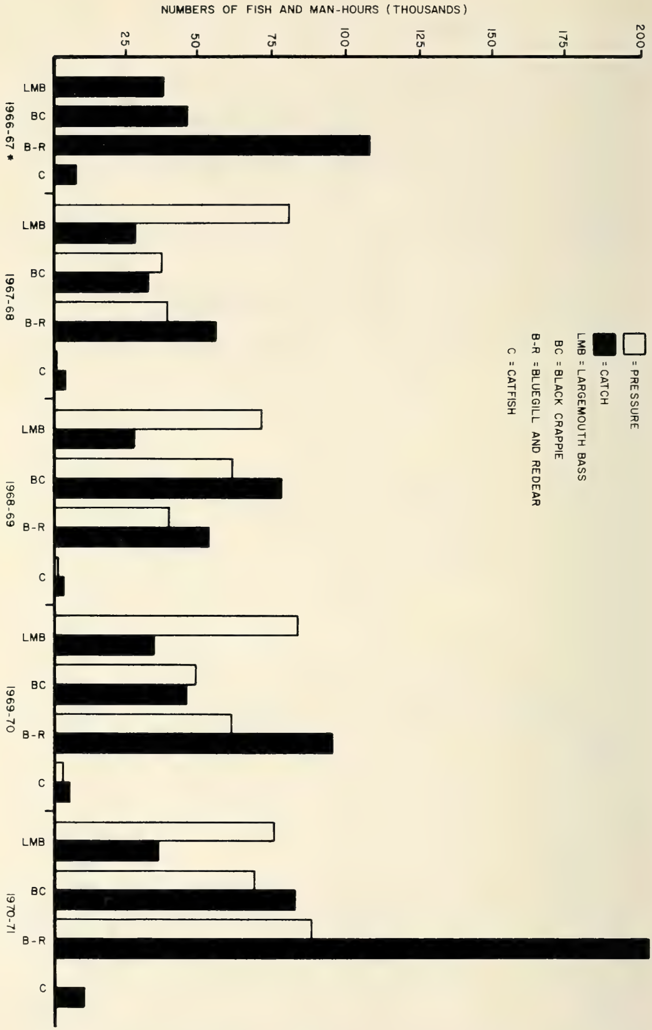


Fig. 3. Estimated fishing pressure by species and catch composition of Lake Harris, 1966-1971. *Pressure by species not available.

Lake Griffin. Probably most significant is the better distribution of the catch or "balance in fisheries quality" for Lake Harris.

Largemouth bass was the number one species fished for by sport fishermen at Lake Harris. Of the total fishing pressure that was estimable at the species level (4 years), 38.9 per cent was directed at largemouth bass. Annual fishing pressure for bass was relatively stable, fluctuating between 72,414-83,058 man-hours (Fig. 3). Only during one creel year, 1970-71, did other species ("bream") outrank bass in fishing pressure. Estimated annual catches of bass varied between 27,246-39,084 fish (Fig. 3). Annual yields fluctuated between 1.6-2.3 bass per surface acre. Bass composition of the catch for the five year creel was 16.4 per cent. Their highest catch composition was 23.5 per cent during 1967-68. The reported average creel-size largemouth bass from Harris was 1 pound 8 ounces.

Bluegill and redear ranked second in fishing pressure by a narrow margin over black crappie. The "bream" fishery comprised 28.7 per cent of the estimated total fishing pressure. Annual fishing pressure for these species varied between 38,850-88,387 man-hours (Fig. 3). During 1970-71 they were the most popular species sought by fishermen. "Bream" dominated the catch of the Harris fishery, comprising 51.9 per cent of the total harvest for the five year period. Annual estimated catches of "bream" ranged from 56,322-201,943 fishes (Fig. 3). Highest annual yield per acre was 12.2 fish in 1970-71. Average size of these species taken in the Harris creel was estimated at 6 ounces.

Black crappie attracted 27.9 per cent of the total pressure and provided 28.8 per cent of the estimated catch in Harris during the study. Annual estimates of pressure varied between 40,422-71,996 man-hours, while annual catches ranged from 34,734-83,628 fish (Fig. 3). Maximum estimated annual yield was 5 crappie per acre. The average creel-size black crappie for Harris was reported at 8 ounces.

Catfish in Lake Harris, as in Griffin, were a relatively minor component of the fishery. The highest annual catch was 10,563 fishes, a composition of 3.2 per cent, and pressure attracted by these species amounted to less than one per cent for any given year (Fig. 3).

Seasonal Distribution of Catches. Seasonal trends in the fish-

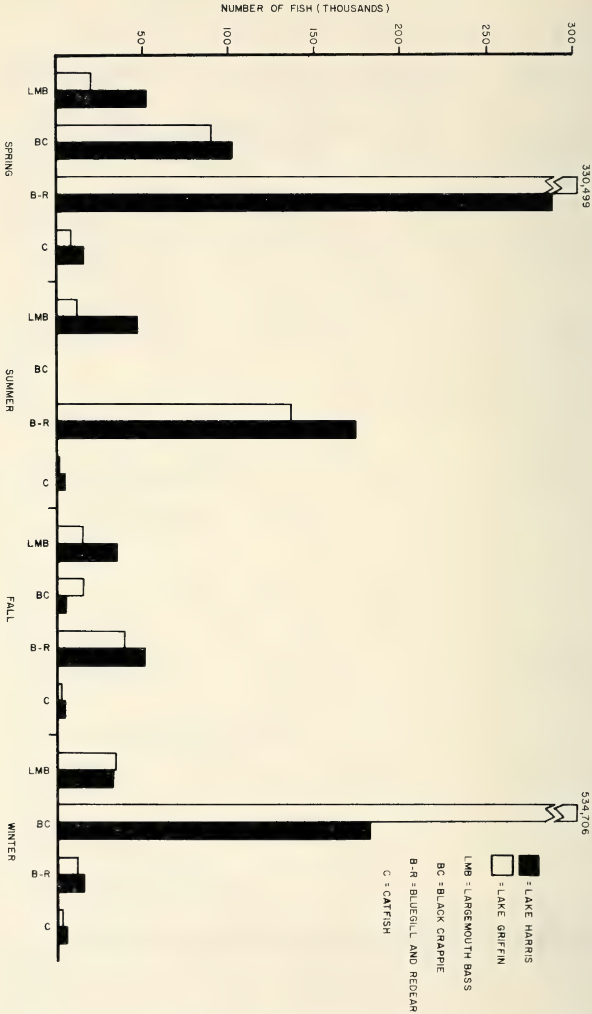


Fig. 4. Estimated seasonal distribution of catch for lakes Griffin and Harris, 1966-1971.

eries for certain species were strongly evident and followed similar patterns in both lakes. Depending on species, a high proportion of the catch was generally made during one or two seasons of the year. Fig. 4 shows seasonal harvest by species for lakes Griffin and Harris over the five year creel period. Trends depicted for these lakes are generally representative for most waters in South Florida (authors observations).

Distribution of seasonal catch was most restricted with black crappie. The principal harvest occurred during winter in both lakes (Fig. 4). Substantial catches were also evident during early spring, but dropped rapidly after mid-April. The harvest of crappie was relatively insignificant during summer and fall seasons.

Bluegill and redear were also seasonal in the fisheries they provided. Highest yields were taken during spring, although summer provided a significant portion of the harvest (Fig. 4). Relatively few "bream" were caught during winter.

Largemouth bass showed very minor seasonal differences in catch (Fig. 4). In Lake Griffin, bass were caught in greatest numbers during winter, in the next greatest numbers during spring. Lowest bass yield was during summer. The largest proportion of the Lake Harris bass catch was during spring and summer, but seasonal differences were small for any given period in this lake (Fig. 4).

Fishing Success. In this study success is determined by the catch rate of numbers of fish for the man-hours of fishing effort. The data are presented in two forms for Lakes Griffin and Harris, general fishing success determined by total fish caught divided by total fishing pressure for a given unit of time (Fig. 1), and fishing success for each species as determined from data obtained from fishermen fishing for a particular species (most fishermen fished for a certain species in this study). Fig. 5 presents fishing success by species for Lakes Griffin and Harris from 1967-1971. Calculations of species success could not be made for creel year 1966-67 because of limitations previously mentioned in creel design.

Overall fishing success for Lake Griffin was relatively stable for the study period. Annual success estimates ranged from 0.91-1.01 fish per man-hour (Fig. 1). The stability exhibited by the Griffin fishery has been largely related to the consistently good fishing afforded by panfishes (Fig. 5).

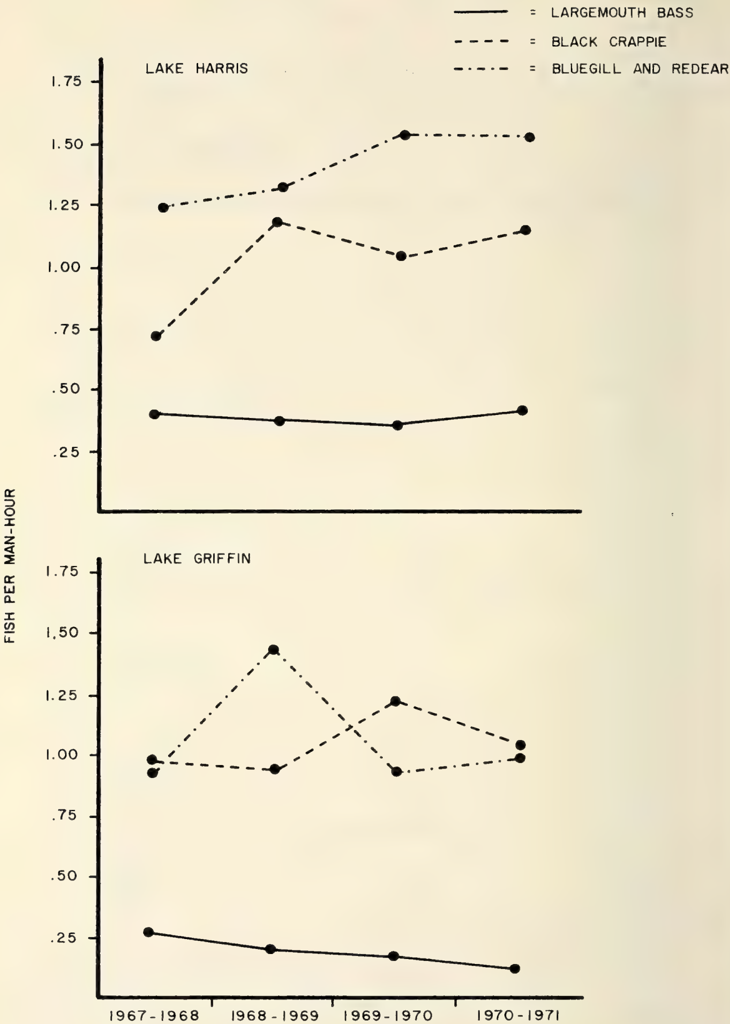


Fig. 5. Fishing success by species effort for lakes Griffin and Harris, 1967-1971.

Fishing success for largemouth bass at Griffin has shown a gradual but steady decline. Our earliest estimate in 1967-68 found an average catch rate of 0.26 bass per man-hour. By 1970-71 success had dropped to an average of 0.14 bass per man-hour (Fig. 5). The decline in bass fishing success is believed to be related to the lake's accelerated eutrophication or rate of degradation. Considerable evidence has been collected in Florida showing largemouth bass to be one of the first species to disappear from a fishery as lakes enter into advanced stages of eutrophication (Fla. Game and Fish Memo Reports, unpublished).

Black crappie have exhibited a relatively stable catch rate in Lake Griffin. Extremes in the estimates of average success have ranged from a low of 0.93 crappie per man-hour in 1968-69 to a high average of 1.22 crappie per man-hour for 1969-70 (Fig. 5). The stabilized nature of the crappie fishery was somewhat unexpected since the species is reputed to be cyclic in its fishery quality.

Lake Griffin bluegill and redear showed the greatest fluctuation in fishing success. The lowest catch rate recorded was in 1967-68, average success of 0.91 "bream" per man-hour, whereas best fishing occurred the following year, an average catch rate of 1.43 "bream" per man-hour (Fig. 5). One interesting aspect of these data is the apparent lack of deterioration in fisheries quality for panfish at a time when lake habitat conditions are known to be degrading (Wilbur, 1969).

Sport fishing quality in Lake Harris showed considerable shifting during the period of study, possibly reflecting better ecosystem dynamics than Griffin. Studies have indicated better habitat conditions and fish population structures associated with Harris (Fla. Game and Fish Memo Reports, unpublished). General fishing success on an annual basis varied between a low of 0.72 fish per man-hour and a high of 1.35 fish per man-hour. During the last three years the catch rate has been maintained at 0.90 fish per man-hour or above (Fig. 1).

Good fishing for largemouth bass, the most sought-after species on Harris, was indicated during the period of record. Success fluctuated very little, ranging between 0.34 bass per man-hour and 0.40 bass per man-hour annually (Fig. 5). Although not as high as reported from some Florida waters (R. L. Wilbur, personal communication), the Harris average catch rate of one bass for less than three

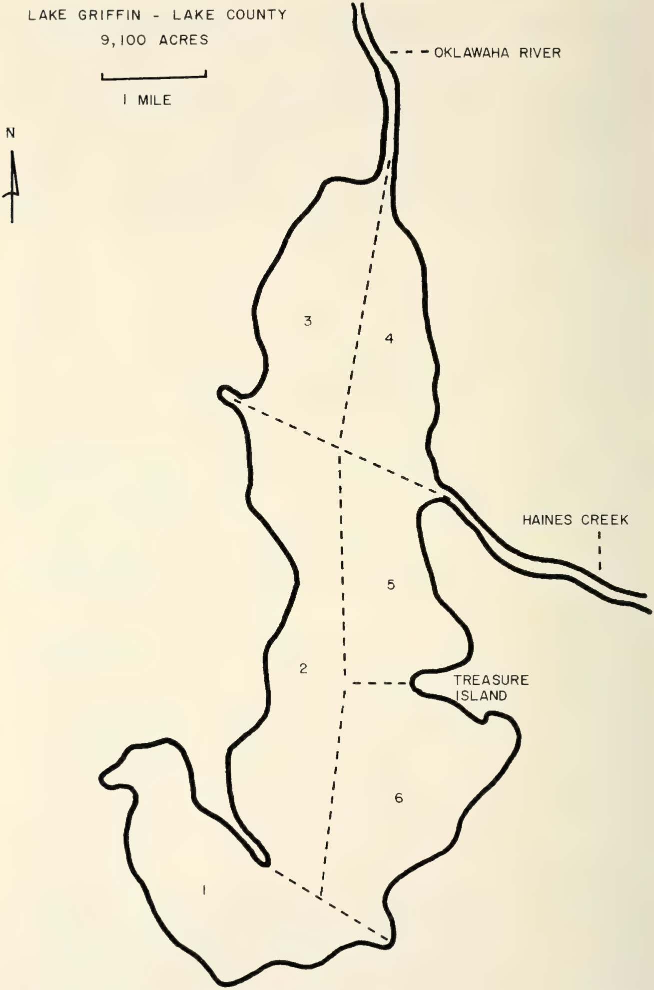


Fig. 6. Creel areas for Lake Griffin.

hours effort compares favorably with national estimates reported by Lagler (1956).

Black crappie maintained a catch rate above one fish per man-hour during three of the four years of record on Harris. During 1967-68 the estimated fishing success was a low 0.70 crappie per man-hour, whereas in the years following fishing success ranged between 1.03-1.17 crappie per man-hour (Fig. 5).

The Lake Harris "bream" fishery provided the highest fishing success of the creel survey. Annual average catch rates were estimated between 1.24-1.55 "bream" per man-hour (Fig. 5).

DISCUSSION AND SUMMARY

Although lakes Griffin and Harris are located within the same watershed and adjacent to the same populous area, the creel survey has shown their fisheries to be of distinctly separate qualities. Sport fishing on Lake Griffin has been largely supported by panfishes; black crappie during the winter months, and bluegill and redear in the late spring and summer. The fishery for largemouth bass has declined steadily since the study began. Bass fishing is now considered to be relatively poor. Fishing pressure and yields per acre were higher on Lake Griffin.

Conversely, the Lake Harris fishery has shown a better catch distribution among available game fishes. Largemouth bass were chiefly responsible for the difference, providing a substantial portion of the annual yield for each creel year. Bass also attracted a major segment of the fishing pressure, which was probably related to the relatively good catch rate. The fishery for panfish showed a trend of general improvement during the study period. Bluegill and redear comprised the greatest portion of the catch, although black crappie yields were of significant importance, especially during winter months.

Fishing success of Lakes Griffin and Harris compared favorably with other waters in the southeast. Davis and Hughes (1963) presented a summary of fishing success for 10 southern reservoirs showing catch rates varying from 0.50-1.96 fish per man-hour. Half of these reservoirs maintained a success rate below 0.90 fish per man-hour, which was the approximate mode for Griffin and Harris. A recent study conducted on Beaver Reservoir, a relatively new im-

Fig. 7. Creel areas for Lake Harris.

poundment in Arkansas, found an average catch rate of 0.62 fish per man-hour (David Morais, personal communication). Jarman et al. (1967), reporting on 12 state owned lakes in Oklahoma, found catch rates ranging from 0.1-0.6 fish per man-hour. Reported fishing success from a popular western reservoir, Lake Meade, was shown to range from 0.30-0.81 fish per man-hour during a 10 year period (Espinosa and Deacon, 1971).

Intensity of fishing pressure and yields from our Florida lakes were generally lower, when compared to other southeastern lakes. Byrd and Crance (1965) found average annual yields of 573 fishes weighing 173 pounds per acre from 20 state owned lakes in Alabama. They did not provide fishing pressure data in man-hours, but as fisherman-trips, which averaged 135 per acre annually. Fishing pressure on Oklahoma's state owned lakes varied between 138-622 man-hours per acre, whereas yields ranged from 68-242 fishes per acre (Jarman et al., 1967). In a study of Bull Shoals Reservoir, Burress (1962) reported fishing pressure as high as 113.9 man-hours

per acre and yields varying between 44-76 fish per acre. The highest annual yield from lakes Griffin and Harris was 33.2 fishes per acre (Griffin) while the heaviest annual fishing pressure was 34.9 man-hours per acre (Griffin). These data indicate the sport fisheries of Florida lakes could withstand considerably more fishermen utilization.

Creel census design used in this study proved suitable to our needs. Man-power required for the water area involved and compilation of data was felt to be reasonable. The creel clerk's job was full time (260 man-days a year), while preparation of data for computer processing approximated 12 man-days a year. Activities of the project leader required only routine supervision of personnel and review of field data and computer output.

Creel estimates provided by the program, as shown in Table 1, were considered to be within acceptable limits. Percent standard deviation of the estimate mean was below 25 per cent for three-fourths of the estimates. The highest per centage was 33.9 per cent (Table 1). For investigators desiring greater estimate precision intensification of sampling effort would be indicated.

ACKNOWLEDGMENTS

The authors extend their sincere appreciation to Dr. Don W. Hayne and Dr. Robert E. Mason, North Carolina State University, for their cooperation and assistance throughout the study. Mr. Dennis Holcomb, Florida Game and Fresh Water Fish Commission, and Mr. James P. Clugston, University of Georgia, are recognized for their contributions to the early phase of the project.

This study was financed in part by Florida Federal Aid in Fish Restoration Project F-12.

LITERATURE CITED

BURRESS, RALPH M. 1962. Quantitative creel census on two arms of Bull Shoals Reservoir, Missouri. Proc. 16th Ann. Conf. S. E. Assoc. Game & Fish Comm., pp. 387-397.

BYRD, I. B., AND JOHNIE H. CRANCE. 1965. Fourteen years of management and fishing success in Alabama's state-owned public fishing lakes. Trans. Amer. Fisheries Sco., vol. 94, no. 2, pp. 129-134.

DAVIS, JAMES T., AND JANICE S. HUGHES. 1963. Creel census on Bussey Brake Reservoir for the first three years. Proc. 17th Ann. Conf. S. E. Assoc. Game & Fish Comm., pp. 284-289.

ESPINOSA, F. A., JR., AND JAMES E. DEACON. 1971. Comparative angler success at Lake Mead (Arizona-Nevada). Prog. Fish Culturist, vol. 33, no. 3, 170-174.

JARMAN, RON, CHARLES BENNET, CHARLES COLLINS, AND BRADFORD E. BROWN. 1967. Angling success and recreational use on twelve state-owned lakes in Oklahoma. Proc. 21st Ann. Conf. S. E. Assoc. Game & Fish Comm., pp. 484-494.

LAGLER, KARL F. 1956. Freshwater fishery biology. W. C. Brown Co., 421 pp.

PFEIFFER, PETER W. 1966. The results of a non-uniform probability creel survey on a small state-owned lake. Proc. 20th Ann. Conf. S. E. Assoc. Game & Fish Comm., pp. 409-412.

WILBUR, R. L. 1969. The redear sunfish in Florida. Florida Game and Fish Comm. Fish Bull. no. 5, 64 pp.

Game and Fresh Water Fish Commission, South Florida Region Office, 2202 Lakeland Hills Blvd., Lakeland, Florida 33801.

Quart. Jour. Florida Acad. Sci. 35(1) 1972

The Presence of *Hyla squirella* in the Bahamas

RONALD I. CROMBIE

BARBOUR (1904) was the first to record the tree frog *Hyla squirella* Sonnini from the Bahamas, on the basis of Museum of Comparative Zoology (MCZ) 2419 and 51983 collected by G. M. Allen on Stranger's Cay, a small island north of Grand Bahama. Stejneger (1905) accepted this and included *H. squirella* in the Bahamian fauna. Barbour (1914, 1930, 1935) retained the species as part of the Antillean fauna in his zoogeographic study and in his first and second lists of Antillean reptiles and amphibians. However, he deleted *Hyla squirella* from the third list (1937) without comment; the species has remained unreported and the record unconfirmed since.

Barbour (1914) re-examined the two Stranger's Cay specimens and compared them with *Hyla femoralis* and *H. carolinensis* (=*cinerea*). He concluded that "there can be no doubt" that they were *squirella*, although he did not compare them with the native Bahamian species, *H. septentrionalis*.

The two "*squirella*" were reidentified as juvenile *Hyla septentrionalis* in the mid 1930's. This presumably was Barbour's reason for deleting the species from his 1937 list. I have examined the specimens and agree that they are recognizable as *H. septentrionalis*, although both are immature (20.3 and 21.1 mm, respectively) and not particularly well preserved.

Despite the reidentification of Barbour's material, the question still remains whether *squirella* does actually occur on Stranger's Cay. Barbour (1904) said of the supposed *squirella*, "Here they were common; and their chirp, as was pointed out at the time by Dr. Allen, who found them, was noticeably different from that of the other indigenous batrachians." He reported no other "indigenous batrachians" from Stranger's Cay in either 1904 or 1914. Furthermore, neither the call of *Hyla septentrionalis* nor that of *Hyla squirella* could be accurately called a "chirp". It must be assumed that Allen was mistaken in his belief that the frogs he collected were producing the sound. Thus, based on present information, it seems unlikely that *Hyla squirella* occurred on Stranger's Cay in Allen's time.

Fig. 1. Map of the Little Bahama Bank, showing Grand Bahama localities for *Hyla squirella* (solid dots). Stranger's Cay is indicated by an arrow.

While studying the MCZ Bahamian collections, I found a number of specimens of recently collected *Hyla squirella*, and later found that additional specimens were recorded in the Albert Schwartz Field Series (ASFS). All are from Grand Bahama; the specimens examined include: MCZ 50631-3; Lucaya, Sept. 15; Oct. 28, 1964. MCZ 52210-2; Lucaya Beach, Dec. 9 and 16, 1964. ASFS V2036-41; West End, July 5, 1959. ASFS V7155; 8 mi. SE West End, Jan. 24, 1966. ASFS V7175-6; 8.2 mi. SE West End, Jan. 24, 1966. ASFS V13604-7; 8.7 mi. NW Eight Mile Rock, Jan. 14, 1968.

All this material is from the western, more heavily populated section of the island. The field notes of James J. O'Hara state that ASFS V2036-41 were collected in a chorus at the West End International Airport. The most easterly record of the species is Lucaya, which is very close to the Freeport International Airport.

The Grand Bahama population is unquestionably the result of an introduction. However, the exact means of introduction is uncertain. The centers of population density around the Bahamian airports plus the abundance of *squirella* around the Miami International Airport freight areas would suggest that the introduction is a byproduct of the heavy air traffic between Miami and Grand Bahama. It is strange, however, that *squirella* has not been found in the vicinity of Nassau on New Providence, since that city shares with Grand Bahama immense popularity as an easily accessible foreign vacation area. It seems logical that stowaways could have turned up there also.

In view of the hit-and-miss prospects for survival of most introduced populations, it is conceivable that the species has been carried to other islands and has not survived. The possible salt tolerance of *squirella* (Neill, 1958) would indicate that this species may be an effective island colonizer and it would not be surprising to find additional colonies on other Antillean islands in the future.

No deleterious ecological effects seem likely from the introduction of *Hyla squirella*. Although the species appears to be well established and breeding on Grand Bahama (MCZ 50633 is a gravid female), it is not likely to become a pest. *Hyla squirella* is a small, arboreal species, which breeds in fresh water pools. It is unlikely that it competes with the local *Eleutherodactylus,* which are terrestrial frogs that breed in wet earth. It is even less likely that *squirella* represents any threat to the much larger Cuban tree frog, *Hyla septentrionalis*. These two species already occur sympatrically in the Keys and along the southern coasts of Florida with no apparent conflict. In fact, it is possible that *septentrionalis* may inhibit the spread of *squirella* in the Bahamas. The Cuban tree frog is an extremely adaptable and hardy creature that can and does feed on other frogs. This species' spread from its native Cuba has been aided by an apparently high salt tolerance (Neill, 1958; Peterson et al., 1952) and by an ability to adapt to life around humans.

SUMMARY

Whereas the earlier record of *Hyla squirella* (Salientia: Hylidae) from Stranger's Cay (Barbour, 1904) is refuted, a relatively recent, unreported population on Grand Bahama is discussed. This

colony probably resulted from the heavy air traffic between Miami and Freeport-West End. No injurious results of this introduction are foreseen. It seems possible that *Hyla squirella* will become established in other suitable Bahamian localities in much the same manner as the Grand Bahama population.

ACKNOWLEDGMENTS

I wish to thank Drs. James A. Peters and George R. Zug for reading the manuscript and for providing laboratory space. I am grateful to Drs. Ernest E. Williams and Albert Schwartz for the loan of specimens and for providing working facilities on my visits to Cambridge and Miami. Dr. Schwartz also deserves special thanks for his continued encouragement and for pointing out the intricacies of the problem dealt with in this paper.

LITERATURE CITED

BARBOUR, THOMAS. 1904. Batrachia and Reptilia from the Bahamas. Bull. Mus. Comp. Zool., vol. 46, no. 3, 55-61.

———. 1914. A contribution to the zoogeography of the West Indies, with especial reference to amphibians and reptiles. Mem. Mus. Comp. Zool., vol. 44, no. 2, pp. 205-359.

———. 1930. A list of Antillean reptiles and amphibians. Zoologica, vol. 11, no. 4, pp. 61-116.

———. 1935. A second list of Antillean reptiles and amphibians. Zoologica, vol. 19, no. 3, pp. 77-141.

———. 1937. Third list of Antillean reptiles and amphibians. Bull. Mus. Comp. Zool., vol. 82, no. 2, pp. 77-166.

NEILL, WILFRED T. 1958. The occurrence of amphibians and reptiles in salt-water areas, and a bibliography. Bull. Mar. Sci. Gulf and Caribbean, vol. 8, no. 1, pp. 1-97.

PETERSON, HAROLD W., RONALD GARRETT, AND JOHN P. LANTZ. 1952. The mating period of the giant tree frog *Hyla dominicensis*. Herpetologica, vol. 8, pt. 3, p. 63.

STEJNEGER, LEONHARD. 1905. Batrachians and land reptiles of the Bahama Islands. *In* George B. Shattuck, editor, The Bahama Islands. Geog. Soc. Baltimore, xxxii + 630 pp.

Division of Reptiles and Amphibians, U. S. National Museum of Natural History, Smithsonian Institution, Washington, D. C. 20560. Present address: *Division of Amphibians/Reptiles, National Zoological Park, Smithsonian Institution, Washington, D. C. 20009.*

Additions to the Pleistocene Avifauna of Arredondo, Florida

CARL DAVID FRAILEY

LATE Pleistocene deposits at Arredondo, Alachua County, Florida, contain a rich avifauna (Brodkorb, 1959). It represents two ecological communities, one a fresh water marsh with adjacent wet meadows, and the other a scrub community. Two additional birds are now added, an extinct vulture and the living short-eared owl, both from Arredondo II. With these additions the total known avifauna from the Arredondo Pleistocene stands at 45 species.

FAMILY CATHARTIDAE

Coragyps occidentalis (L. Miller)

Distal end of juvenile right tibiotarsus, PB 8422. This element is more robust than in the living black vulture, *C. atratus* (Bechstein).

The least anterior width of the intercondylar sulcus measures 4.3 mm in the Arredondo fossil. Six tibiotarsi of *C. occidentalis* from the Pleistocene of Reddick, Florida, measure 3.6-4.2 (mean 4.3). In recent specimens the comparable measurement is 2.7-3.7 (mean 3.2) in nine *C. a. atratus* from Florida, and 2.9-3.1 (mean 3.0) in three *C. a. brasiliensis* from the tropics.

The distal width of the Arredondo tibiotarsus is 13.4 mm, and it is 13.0-13.9 (mean 13.5) in four *C. occidentalis* from Reddick. In nine Recent *C. a. atratus* it measures 11.3-12.0 (mean 11.7), and in three Recent *C. a. brasiliensis* 13.0-13.9 (mean 13.4). The measurements of the fossils from Arredondo and Reddick compare well with those of 17 tibiotarsi of *C. occidentalis* from the Pleistocene of San Josecito, Nuevo León (Howard, 1968).

Coragyps occidentalis is known from three sites in Florida, Reddick (Brodkorb, 1957), Haile XI B (Ligon, 1965), and now Arredondo.

FAMILY STRIGIDAE

Asio flammeus (Pontoppidan). Distal end of right tibiotarsus, PB 8423.

The short-eared owl is separable by size from all other owls except *Asio otus*. Although very similar superficially, the shaft of *Asio otus* is smaller, and there is a small groove on the anterior, inner (intercondylar sulcus facing) surface of the external condyle not found on *A. flammeus*.

This is only the second fossil occurrence of *Asio flammeus* in Florida. Ligon (1965) reported the first from Haile XI B.

These additions to the avifauna strengthen the conclusion that the sites at Reddick, Arredondo, and Haile XI B are of approximately the same age, whether Sangamon (Webb, in press) or more generally Rancholabrean (Ligon, 1965).

LITERATURE CITED

BRODKORB, PIERCE. 1957. New passerine birds from the Pleistocene of Reddick, Florida. Jour. Paleo., vol. 31, no. 1, pp. 128-138.

———. 1959. The Pleistocene avifauna of Arredondo, Florida. Bull. Florida State Mus., vol. 4, no. 9, pp. 269-291.

HOWARD, HILDEGARDE. 1968. Limb measurements of the extinct vulture, *Coragyps occidentalis*, with a description of new subspecies. Papers Arch. Soc. New Mexico, vol. 1, pp. 115-128.

LIGON, J. DAVID. 1965. A Pleistocene avifauna from Haile, Florida. Bull. Florida State Mus., vol. 10, no. 4, pp. 127-158.

WEBB, S. DAVID. In press. Chronology of Pleistocene land mammals of Florida. *In* S. David Webb, editor, Pleistocene mammals of Florida. University of Florida Press, Gainesville.

Florida State Museum, University of Florida, Gainesville, Florida 32601.

Quart. Jour. Florida Acad. Sci. 35(1) 1972

Avifauna of Little Tobago Island

James J. Dinsmore

In recent years the study of island populations has received considerable attention, especially the dynamic aspects of species composition (e.g. Diamond, 1969). As some of these studies have depended on limited lists of insular faunas, the following intensive study of the avifauna of one island should be of value. From 23 September 1965 to 4 July 1966 I lived on Little Tobago Island in the southern West Indies and compiled a list of the birds found there along with population counts and other notes on the bird's habits. Roldan George of Speyside, Tobago, assisted throughout my stay and continued observations from 4 July to 30 September 1966. Unless otherwise noted, all records refer to the period 1 October 1965 to 30 September 1966.

Little Tobago, a 280-acre island located at 11°18′N, 60°30′W, is about 1 mile off the northeast coast of Tobago. The island is very hilly with virtually no level ground and a maximum elevation of 464 feet. It has no permanent ponds or streams but one small spring flows throughout the year.

Little Tobago has no permanent human inhabitants although a caretaker spends occasional nights on the island and people have lived there at various times in the past. Since 1928 it has been a game sanctuary and all forms of wildlife are protected. Local people have released goats on the island but in mid-1966 all of them had been removed. Although a tree rat (*Rhipidomys*) has been described from the island (Goodwin, 1961), I found no evidence of it in 1965-66 and believe that perhaps its type locality is Tobago proper.

Temperatures normally reach the low 80's during the day and drop to about 70F at night. Rainfall in 1966 exceded 85 inches. The dry season lasted from mid-February to 19 April when 3.42 inches of rain fell. June and November were the wettest months. Hurricanes are rare on Little Tobago but one in 1963 did extensive damage to the vegetation.

The vegetation is mainly a deciduous seasonal forest (Beard, 1944), within which several distinct vegetation types occur. The deciduous forest has an almost closed canopy and a scattered understory, and it is found over much of the wind-protected parts of the

island. The upper canopy ranges up to 50 feet in height but most of the trees are from 35-45 feet tall. The fan palm (*Coccothrinax australis*) and Gumbo-limbo (*Bursera simaruba*) are by far the most common trees in the upper canopy. Young *Coccothrinax* are the most common trees in the understory but *Eugenia* sp. and *Mayepea caribaea* are also common. The aroid *Anthurium hookeri* is abundant at ground level. The degree of deciduousness varies with the length of the dry season, *Bursera* being one of the first to drop its leaves. In wet years leaffall is incomplete. Most of the understory species are evergreen.

Several parts of the island that were probably originally deciduous forest were extensively damaged by the hurricane in 1963. These parts now have few tall trees and are covered with thick masses of almost impenetrable low brush. The rapid growing tree *Cordia collococca* and the shrub *Aphelandra incerta* are common in these areas.

Thick tangles of cactus (*Cereus hexagonus, Hylocereus lemairei,* and *Cactus broadwayi*) and *Plumbago scandens* cover the steep slopes and cliffs on the lower levels of the island, particularly on the windward (east) side. Near sea level the vegetation is windswept and planed off with a low mat of vines covering the ground.

Several almost pure stands of *Coccothrinax australis* are concentrated on the windward side of the island above the cliff vegetation. These stands have few trees in the understory and again *Anthurium hookeri* is abundant at ground level.

Eleven small garden plots cover about 8 acres, mainly in bananas (*Musa* sp.). The gardens also have guava (*Psidium guajava*), sapodilla (*Achras zapota*), and mango (*Mangifera indica*) with lesser numbers of several other species. Papaya (*Carica papaya*) was cultivated on the island for the birds but now grows wild, mainly in openings such as those produced by the hurricane. Several abandoned gardens and a few acres around the two cabins are overgrown with tall grass.

Although many ornithologists and naturalists have visited Little Tobago to see the introduced birds of paradise, few have made more than casual reference to other birds they saw. I have reviewed the history of birds of paradise on Little Tobago elsewhere (Dinsmore, 1970) and will not consider it in detail here. Despite all this

work, no one has previously published a complete listing of the avifauna of this island.

The most recent listing of the birds of Tobago (Bond, 1970) mentions several species that occur on Little Tobago, all of which were either seen by me in 1965-66 or have been published previously.

In an attempt to estimate the population of all nesting land birds, I divided Little Tobago into 36 sections, using paths and natural features for division lines. These sections varied considerably in size. I traversed each of these alone or with another experienced observer and stopped often to note birds heard or seen. Except for thrushes which were more active in the evening, all counts were made prior to 10:00 AM from March through June. Each bird seen or heard was recorded on a field map and later these records were transferred to maps of the whole island, one map per species. Except for the extremely rough southeast corner of the island, all sections were covered at least once and some counts were refined when it was obvious that I had erred in my original count. The totals of the counts for each species are given in the left column of Table 1. While many times we saw what probably were both members of a pair, other times we saw or heard only one individual but undoubtedly a second was present, perhaps on a nest. The right column of Table 1 gives totals per species when these "unseen but probably present" individuals are added to the totals. This gives a probable maximum number per species for the island.

I am aware of the pitfalls of my methods but with the limited time available it was the only means possible. The counts were made over a long period of time and certainly some birds moved from one section to another, died, or young birds were added to the island although I excluded the latter whenever their age was obvious. The counts are certainly better than a guess and give at least some idea of the abundance of birds on Little Tobago.

I counted other nesting species by a variety of methods. Some were counted as they entered roosts (anis, cowbirds), as they flew at peak hours of activity (swifts, martins, hawks), at nesting colonies (oropendolas), or from a boat or promentory where I could see a lengthy stretch of shoreline (seabirds). Population estimates

TABLE 1
Population estimates of some Little Tobago birds

Species	Number seen in counts	Probable maximum number present
Wild Fowl	141	150
Pale-vented Pigeon	92	120
White-tipped Dove	297	400
Rufous-breasted Hermit	57	75
Black-throated Mango	17	30
Ruby-topaz Hummingbird	90	175
Copper-rumped Hummingbird	57	80
Blue-crowned Motmot	245	350
Tropical Kingbird	101	130
Brown-crested Flycatcher	304	375
Yellow-bellied Elaenia	173	235
House Wren	359	600
Tropical Mockingbird	704	725
Bare-eyed Thrush	179	310
Red-eyed Vireo	129	210
Bananaquit	583	840
Blue-gray Tanager	250	310
Blue-black Grassquit	13	25
Black-faced Grassquit	134	175
Lined Seedeater	14	25
Yellow-bellied Seedeater	12	25

for these species are given in parenthesis after the species account.

In all I saw 59 species of birds on Little Tobago. The vernacular and scientific names follow those of Meyer de Schauensee (1966).

ANNOTATED LIST OF SPECIES

Puffinus lherminieri. Audubon's Shearwaters nest in the thick masses of cactus and vines on the sea cliffs and in open stands of fan palm where they burrow among the root masses of *Anthurium.* I first found adults in nest burrows in early December and first saw eggs on 24 January. Egg-laying continued until at least mid-February but most occurred during the last week of January and the first of February. Two eggs had incubation periods of 51 and 52 or 53 days. The young remained in the nest burrows until late May or early June. Eleven young birds stayed in the burrows an average of about 75 days before leaving.

I found 27 dead shearwaters with the sternum and neck stripped of flesh. As I never saw shearwaters flying near the island in daylight, they were probably killed by Barn Owls (*Tyto alba*). Seven that I found on 9 June had been killed in the previous two days and were probably young birds just out of the nest burrow.

I did not hear adults calling over the island in June when the young were leaving the nests but by mid-August adults again were near the island. Brown (1947) found numerous eggs and some downy chicks on 31 March 1940 and Collins (1969) found partially grown downy young on 29 April 1967, indicating that the breeding cycle apparently is annual. (1,000)

Phaethon aethereus. I first saw Red-billed Tropicbirds on 27 September 1965 when two circled near the island. Their numbers gradually increased, reaching a peak from December through February and then decreasing until the last ones left in August. They nest in crevices or under masses of cactus on the cliffs. I saw a downy chick as early as 4 January but other nests contained an egg as late as 21 March. Young birds started leaving the nests in April but some were still present in late June.

Brown (1947) saw some eggs and downy to nearly fledged chicks on 31 March 1940. Bond (1958) saw this species here on 29 January 1958 and considers the records of *P. lepturus* from Tobago (Belcher and Smooker, 1934) doubtful (Bond, 1962), a stand I agree with. (500)

Pelecanus occidentalis. Except for three seen on 25 March, Brown Pelicans were absent from 15 February to 4 July, but during the rest of the year I saw some at least several times each month. In the period of absence, which coincides with their nesting season at their nearest colony on Saut D'Eau Island, Trinidad (Brown, 1947), pelicans were still common on the western end of Tobago. I saw no sign of pelicans nesting on Little Tobago.

Sula sula. Red-footed Boobies nest on St. Giles Island and outlying rocks 3.5 miles north of Little Tobago (Dinsmore and ffrench, 1969) and commonly fly near or over Little Tobago.

Sula leucogaster. A common resident, Brown Boobies usually nest on steep slopes near the sea. Of 220 nests I located, I was able to estimate the date of laying of 103 eggs to the nearest third of a month, using the dates young reached various plumages and back dating. I used plumage information compiled by Dorward

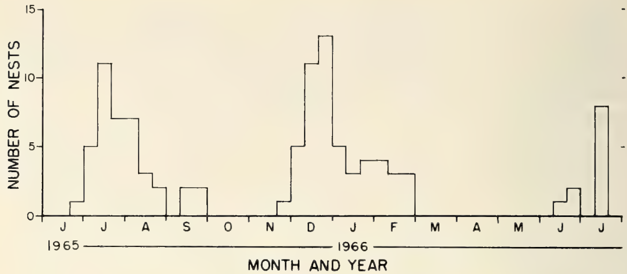


Fig. 1. Estimated time of egg-laying, in one-third month intervals, for 103 nesting attempts by *Sula leucogaster* on Little Tobago, West Indies.

(1962) as a guide to ages. I found two definite peaks of egg-laying (Fig. 1), one in July and early August and the second in December. Limited data from a small part of the island indicates another peak of laying in the summer of 1966, roughly a year after the one in 1965. All the young in the other nests I located seemed to fit into one or the other of the two main peaks but I could not accurately determined the date of egg-laying. Schreiber and Ashmole (1970) note that Brown Boobies often have two peaks of breeding per year. (600)

Fregata magnificens. A few Magnificent Frigatebirds nearly always are flying over Little Tobago but I never saw one land on the island. Several thousand frigatebirds frequent nearby St. Giles Islands where they nest (Dinsmore and ffrench, 1969).

Florida caerulea. Both adult and immature Little Blue Herons were common along the rocky shoreline from September 1965 to December, February, and again from June through September 1966. I saw no nesting activity.

Nyctanassa violacea. I saw Yellow-crowned Night Herons every month except November and December. They often roosted in the dense shrubs above the cliffs and fed along the rocky shoreline. On 26 April I saw two adults manipulating sticks at what appeared to be the start of a nest, but they soon abandoned it. (4)

Coragyps atratus. I saw single Black Vultures over Little Tobago on six occasions between 25 September and 27 May. Only recently added to the avifauna of Tobago (Herklots, 1961), it also has been seen at nearby St. Giles (Dinsmore and ffrench, 1969).

Buteo platypterus. I saw Broad-winged Hawks almost daily but I saw no sign of their nesting. The nest mentioned by Baker (1923) presumably was of this species.

On 2 May I counted 41 Broad-wings circling high over the island while two others stayed low and away from them. The large group gradually circled back toward Tobago where I lost sight of them. These may have been migrants although on 31 March I saw 13 Broad-wings over the island. A specimen of the North American race of the Broad-wing has been taken on Trinidad (Bond, 1968). (3)

Pandion haliaetus. I occasionally saw a single Osprey from 16 October through 17 March and again from 29 August through 10 September.

Falco peregrinus. I saw Peregrine Falcons often from 21 October to 17 December and again from 28 January to 27 April. At least two individuals were present. A regular winter visitor to Little Tobago (Herklots, 1961), both Bond (1958) and Gilliard (1969, p. 413) have seen it there in recent years.

Gallus gallus. Wild fowl may have been introduced to Little Tobago around 1875 (Ingram, 1913) and certainly were present in 1909 (Ingram, 1911). They are shy and stay low in the brush, being most abundant near the gardens. Wild fowl nested in December, May, and June.

Arenaria interpres. I saw groups of two to four Ruddy Turnstones along the rocky shoreline on three occasions (24 October, 22 April, 19 May).

Actitis macularia. Spotted Sandpipers are rather common along the shoreline, extreme dates being 10 September 1966 and 19 May.

Larus atricilla. Laughing Gulls arrived on 9 March and rapidly built up to peak numbers. I first found a nest with eggs on 27 April. Egg-laying reached a peak by mid-May and many eggs had hatched by 10 June. Most nests contained one or two eggs although a few had three. All the gulls had left the island by late August. Gulls may have nested on Little Tobago in April 1930 (Belcher and Smooker, 1935). (750)

Sterna dougallii. A few *Sterna* terns were present until early October in both 1965 and 1966. On 7 April I saw *Sterna* terns near Little Tobago and on 22 April 30-40 Roseate Terns were on the

south side of the island. Late in May I saw terns (almost certainly Roseates) foraging near Little Tobago and on 28 May I located their nesting colony on the northeast tip of Tobago (Dinsmore and ffrench, 1969). They continued to feed near Little Tobago in June and July and several times I saw adults with flying young.

Sterna anaethetus. I found Bridled Tern eggs close to the shoreline all around Little Tobago, sometimes under rock and rubble just out of reach of high waves. As this species resembles the Sooty Tern, I may have overlooked it before I first noted one on 2 April. Eggs apparently were laid from mid-April through May and I saw several chicks in June. By late August this species had left the island. Although Herklots (1961) lists only Smith Island as a breeding locality for this species on Tobago, it probably nests regularly on Little Tobago. (150)

Sterna fuscata. I first saw Sooty Terns near the island on 8 March and on 9 March they were landing. I first noted eggs on 23 March and egg-laying continued into April. I first saw chicks in early May but some probably hatched earlier. Sooty Terns nest on the steep sea cliffs, especially under masses of cactus and in clumps of *Plumbago.* By 8 August most had left the island. An earlier record for Little Tobago indicates egg-laying occurred in April 1959 (in Ashmole, 1963). (2,100)

Anous stolidus. A few Brown Noddies were present around Little Tobago as late as 22 October 1965 but then were absent until 9 March when they arrived with the Sooties and Laughing Gulls and rapidly built up in numbers. I first saw eggs on 12 April and by mid-May chicks were present. They nest in low trees, among the thick masses of cactus, and on rocky ledges all around the island. Most had left the island by mid-August but a few remained into September and perhaps later.

Belcher and Smooker (1935) suggest that the Brown Noddy and Sooty Tern nest in Tobago both in April and July but I saw no evidence of this in 1966. (1,200)

Columba cayennensis. Pale-vented Pigeons are common in the deciduous forests. I found one nest in November and two each in May and June. Of the latter four, three each had a single white egg and the fourth had a young bird. Nests were generally low in trees, often in the thick dry cliff vegetation.

Columbina talpacoti. Although the Ruddy Ground-dove is

common in dry shrubby areas on nearby Tobago, on Little Tobago I saw single birds only four times in late October. All were in the dry shrubby areas around the cabins.

Leptotila verreauxi. The White-tipped Dove is most abundant in the deciduous forest and fan palm stands. I found ten active nests, most of them a shallow platform of twigs and sticks low in a tree or bush. Egg-laying in nine of them apparently started in March (3), May (2), June (3), and July (1).

Coccyzus americanus. I saw a single Yellow-billed Cuckoo in one of the gardens on 12 October.

Crotophaga ani. Smooth-billed Anis are a common resident in the open brush and gardens. On 1 January I found an abandoned nest in some tall grass between the two cabins. (70)

Tyto alba. I occasionally saw two Barn Owls from 23 March to July but they probably had been present prior to that time. Seabirds, especially the nocturnal Audubon's Shearwater, apparently form a major part of their diet. (2)

Nyctibius griseus. I regularly heard a Common Potoo on calm evenings throughout the year. Although I searched for it, I never saw one. The visitor's book on Little Tobago contains a record of one being seen on 4 March 1963. (2)

Caprimulgus cayennensis. The resident White-tailed Nightjar is conspicuous over open areas in early morning and late evening. I found two nests on bare ground, one with one egg on 14 February and subsequently deserted and the second with a fresh egg on 3 May. A second egg was present by 7 May and both hatched on 23 May. Adults gave no distraction display when disturbed from brooding. By 4 June the young could fly and on 8 June the nest site was deserted. (10)

Chaetura brachyura. The Short-tailed Swift is a common resident. On 30 May I could hear young birds calling from inside two hollow trees but I could not reach the nests themselves. (200)

Glaucis hirsuta. The Rufous-breasted Hermit is a resident in deep forested ravines, especially near *Heliconia.* I found only two nests containing eggs, one each in December and March.

Anthracothorax nigricollis. I usually saw Black-throated Mangos perched high in trees at the edge of openings in the forest. I found one nest 20 feet up in a *Cecropia* tree on 3 May but could not reach it to see if it had eggs or young.

Chrysolampis mosquitus. I first saw a Ruby-topaz Hummingbird on 3 December and soon they were common throughout the island. They seemed to prefer the forest edge but stayed lower than *Anthracothorax.* I found nests with eggs on 20 January and 17 June but both were soon abandoned. I saw other nests being built but found no broods.

Some birds were still present in early August but then apparently left. Their calls and flashy colors make them hard to miss and I am sure that they were absent until early December 1965. On Tobago they have been noted as being absent from August to February (Jardine, 1833).

Amazilia tobaci. The Copper-rumped Hummingbird is a common resident low in the deciduous forest. I found nests with two eggs in November, January, and June and several others that were abandoned before eggs were laid.

Ceryle alcyon. I saw a Belted Kingfisher on 26 and 29 November and 10 June and another one at nearby Speyside on 4 November.

Momotus momota. The Blue-crowned Motmot is an abundant resident, seldom leaving the protective canopy of the deciduous forest and fan palm stands. I located many nest burrows on steep hillsides and banks on the island. In two I could examine the eggs hatched around 30 May and 5 June at which time nesting seemed to be active throughout the island. Both nests fledged two young although a third egg in one failed to hatch and a third young bird in the other grew slowly and was evicted from the nest when about 15 days old. One nest was at the end of a straight 4-foot burrow in a bank while the other was in an *Anthurium* root mass and just a few inches from the entrance. I saw adults bring millipedes, scorpions, large insects, and small lizards to the young.

Tyrannus melancholicus. Tropical Kingbirds are a common and conspicuous resident of openings in the deciduous forests and hurricane-disturbed areas, usually staying high in the vegetation.

Tyrannus dominicensis. I saw single Gray Kingbirds in hurricane-disturbed habitat on Little Tobago on 13 October, 26 April, and 2 May.

Myiarchus tyrannulus. The Brown-crested Flycatcher is abundant in deciduous forests and fan palm stands, generally staying lower in the canopy than does *Elaenia.* I found several nests in

hollow trees but none were accessible to me. Egg-laying apparently took place from early January into February. I saw adults taking food to one nest early in February.

Cnemotriccus fuscatus. I saw single Fuscous Flycatchers only four times (5 and 17 October, 21 April, 3 July) but it may have been resident. Each was in dry brush at the edge of a garden or in a clump of bamboo.

Elaenia flavogaster. Yellow-bellied Elaenias are common high in the canopy throughout the heavily forested parts of the island. Although I found no nests, it probably nested in February and March.

Progne dominicensis. Caribbean Martins were common on Little Tobago in late September 1965, still present on 17 and 29 October, and then absent until 10 February. After 15 February I saw them almost daily. I saw birds going into cracks and crevices in cliffs along the coast in May and June and they probably nested there. (50)

Paradisaea apoda. In September 1909 Sir William Ingram released 48 Greater Birds of Paradise on Little Tobago (Ingram, 1911). These birds, of unknown sex, had been secured on the Aru Islands off the coast of New Guinea. By 1958 certainly 15 and perhaps 35 birds were present (Gilliard, 1969, p. 414).

In 1965-66 I located with certainty only 7 *apoda;* 4 adult males, 1 sub-adult male, and 2 female-plumaged birds. Males displayed in every month with a peak in late February and March (Dinsmore, 1969). I saw birds copulate but found no nests or signs of nesting activity. They mainly utilized undisturbed areas of deciduous forest but occasionally visited hurricane-disturbed areas and fan palm stands. (7)

Troglodytes aedon. The House Wren is an abundant resident on Little Tobago, almost every brushy area and ravine having a pair.

Mimus gilvus. Next to the Bananaquit, the Tropical Mockingbird is the most abundant land bird on Little Tobago. It is common in all habitats, especially the brushy hurricane-disturbed areas. I found nests with young on 3 April and 18 June. On 24 June I found a nest with a mockingbird egg and chick and one *Molothrus bonariensis* egg.

Turdus nudigenis. Bare-eyed Thrushes are abundant in hur-

ricane-disturbed areas and thick stands of deciduous forest but are retiring and heard more often than seen. I found nests with 2 and 3 chicks in late June and early July.

Vireo olivaceus. Red-eyed Vireos are common in deciduous forests and hurricane-disturbed areas but were less evident from October to mid-February and some may have left the island in that period. One nest started on 8 March was soon abandoned, apparently after eggs had been laid. Another nest contained three young on 22 June, two of which fledged.

Molothrus bonariensis. The Shiny Cowbird is common in the open areas around the cabins and gardens. I found one cowbird egg in a mockingbird nest on 24 June. (50)

Psarocolius decumanus. Crested Oropendolas are common in the deciduous forests and fan palm stands although they range over the whole island. I located six nesting colonies containing about 120 nests. Five were in tall Royal Palms (*Roystonea oleracea*) and the sixth was in a tall *Spondias monbin.* They probably nested in January as young birds appeared out of the nests in late February. (200)

Protonotaria citrea. I caught, photographed, and released a male Prothonotary Warbler on 24 October.

Dendroica striata. I saw single Blackpoll Warblers foraging in low brush in hurricane-disturbed areas on 15 October and 2 November.

Seiurus aurocapillus. I saw an Ovenbird on 21 November and again on 11 March, apparently the first sight records for this species in Trinidad and Tobago. In both cases I clearly saw the striped breast, reddish crown, and lack of an eye stripe. Ovenbirds previously have been reported wintering in northern South America and also as far down the Lesser Antilles as St. Vincent, 170 miles to the north (Bond, 1956).

Seiurus noveboracensis. I saw single Northern Waterthrushes 10 times between 2 October and 5 January and again on 4 and 7 April.

Coereba flaveola. Bananaquits are the most abundant and widely distributed land bird on the island. I saw them most often in deciduous forests and hurricane-disturbed areas but they occur throughout. I found nests with eggs in November and December and nests with young in March.

Red-legged Honeycreeper (*Cyanerpes cyaneus*). This species occurs sporadically in the gardens and deciduous forest, birds being seen in October and fairly regularly from March to June. Roldan George saw a pair copulating on 5 April but we found no nests.

Thraupis episcopus. Blue-gray Tanagers are abundant in the deciduous forests and fan palm stands. I did not find any nests but I saw recently fledged young on 10 January and 18 March.

Volatinia jacarina. Blue-black Grassquits live in the dry shrubby cover around the gardens. They were absent from late October until mid-March except for one seen on 15 February.

Tiaris bicolor. The Black-faced Grassquit is the commonest finch on Little Tobago, and apparently the only one that is resident. It is common in brushy areas around the gardens and hurricane-disturbed areas. Roldan George found a nest containing three eggs on 10 September.

Sporophila lineola. Lined Seedeaters are absent from the island from late October until late May. They occur in open areas around the cabins and gardens and probably breed on the island.

Sporophila nigricollis. Yellow-bellied Seedeaters are fairly common in open areas around the gardens and cabins. Except for single birds on 17 December and 9 and 10 April, I saw none on Little Tobago from late October to May. I saw recently fledged young early in October 1965.

Besides the species I saw in 1965-66, several others have been reported from Little Tobago. These include the American Oystercatcher (*Haematopus palliatus*) (Herklots, 1961), *Zenaida auriculata* (Bond, 1959), another hawk, possibly *Buteo nitidus* (Gilliard, 1969, p. 413), and the Black Noddy (*Anous tenuirostris*) (Kleinwort, 1967).

DISCUSSION

A puzzling feature of the avifauna is the lack of suboscines other than the flycatchers. Ten species in five families occur on Tobago (Herklots, 1961), some of them being abundant. At least three are montane forest forms and thus would not find suitable habitat on Little Tobago but others such as *Thamnophilus doliatus* and *Formicivora grisea* live in low shrubby woodland on Tobago, only 2 miles from similar habitat on Little Tobago.

Thus Little Tobago has less than half the number of species of

birds found on nearby Tobago (ca 170) although the lack of montane rain forest and freshwater habitats certainly account for much of the difference. Tobago has a land area of 114 square miles, some 200 times the size of Little Tobago and this too helps account for the difference in number of species.

Of the 59 species reported here, I saw an egg, a nest, or recently fledged young or know of breeding records for 30 species. An additional seven species (*Tyrannus melancholicus, Elaenia flavogaster, Progne dominicensis, Troglodytes aedon, Cyanerpes cyaneus, Volatinia jacarina,* and *Sporophila lineola*) almost certainly breed on the island. The potoo, Barn Owl, Yellow-crowned Night Heron, and Fuscous Flycatcher also may breed there occasionally.

Most species for which I have nest records nest in May through July at the start of the wet season. The limited evidence I have for finches indicates they breed late in summer. On nearby Trinidad the Snows (1964) found a seasonal nesting pattern similar to that I found on Little Tobago.

Several land birds seem to leave Little Tobago for part of the year. All four finches probably nest on the island but apparently only *Tiaris* is resident. I did not see the other three for most of the winter and I doubt that I could have overlooked them. This movement may be very local as the Eastmans (1958) saw all four on Tobago between 16 January and 20 February.

I have already commented on the absence of *Chrysolampis mosquitus* in the fall and *Progne dominicensis* in winter. *Vireo olivaceus* seemed to be much less abundant in winter but may have just called less then and was not noticed.

On the basis of observations in 1965-66 and records from the literature, with the possible exception of the Brown Booby, all the seabirds on Little Tobago breed annually although not all at the same time. The terns and the Laughing Gull are absent from late summer to March or April and begin laying eggs soon after they return. Tropicbirds have a more extended laying period, extending at least from November to February. All leave Little Tobago for at least a month in late summer and individual birds are absent for longer periods. Audubon's Shearwaters apparently are present for much of the year. Their egg-laying is more synchronized and is mainly in late January and early February. The Brown Boobies have two peaks of laying, late summer and again in winter, but

individual birds have not been marked to determine whether these are separate groups of adults or if some are renesting attempts.

All of the above seabirds probably nest on nearby St. Giles Islands. The nesting information available indicates that the individual species have similar nesting periods on St. Giles and Little Tobago (Dinsmore and ffrench, 1969). Both the Brown Noddy and Sooty Tern lay in April on Soldado Rock off the southwest coast of Trinidad (Belcher and Smooker, 1935; Ashmole, 1963).

Aruba, Bonaire, Curacao, Islas Las Aves, Isla La Orchila, Islas Los Roques, Islas Los Hermanos, and Los Testigos, all at about the same latitude as Little Tobago and to the west, have a variety of seabirds breeding on them. These include all the terns found on Little Tobago, the Laughing Gull, and, on some, boobies, Red-billed Tropicbirds, and Audubon's Shearwaters. In general the terns and Laughing Gulls breed from May to July although the two noddies on Los Roques and the Sooties on La Orchila start breeding in February and March (Van der Werf et al., 1958; Phelps and Phelps, 1959a, b; and Voous, 1963).

Shearwaters and tropicbirds breed in February and February to April respectively, while Brown Boobies have a more extended nesting period, perhaps from February to September. On Los Testigos and Los Hermanos the boobies and tropicbirds had eggs or young birds in January (Lowe, 1909). More information on the shearwaters, boobies, and tropicbirds especially is needed. In general however, the breeding seasons of seabirds on these islands roughly coincide with those on Little Tobago.

The factors determining the timing of these seasons remain unknown. The two peaks of breeding by Brown Boobies are particularly puzzling but for the spring nesting species I can suggest two possibilities. On Little Tobago, much as on Curacao (Ansingh et al., 1960), local fishing activity intensifies in March and April when numbers of large predatory, commercially valuable species arrive. Presumably this also means the arrival of smaller fish which may be food for both fish and seabirds. Another possibility on Little Tobago is that the Orinoco River in Venezuela floods from March to mid-summer. Changes in the water are evident at Little Tobago and perhaps this has some effect on seabird food supplies but again more information is needed.

Acknowledgments

Initiated and financed in part by the Forestry Division, Ministry for Tobago Affairs, this study was made possible by the efforts of R. G. Miller of that Department and Hollis Murray, then Conservator of Forests, Trinidad and Tobago. Roldan and Jeremiah George of Speyside, Tobago, helped in innumerable ways in the field work with the former providing three months of records to make this a full year study. John T. Emlen, my faculty advisor, encouraged me throughout this study. Graduate fellowships from the University of Wisconsin, Madison helped finance the work. David W. Johnston and Alexander Cruz read drafts of this paper and offered helpful comments.

Literature Cited

Ansingh, F. H., H. J. Koelers, P. A. Van der Werf, and K. H. Voous. 1960. The breeding of the Cayenne or Yellow-billed Sandwich Tern in Curacao in 1958. Ardea, vol. 48, pp. 51-65.

Ashmole, N. P. 1963. The biology of the Wideawake or Sooty Tern *Sterna fuscata* on Ascension Island. Ibis, vol. 103b, pp. 297-364.

Baker, H. D. 1923. Birds-of-paradise at Little Tobago Island. Bird-Lore, vol. 25, pp. 295-302.

Beard, J. S. 1944. The natural vegetation of the island of Tobago, British West Indies. Ecol. Monographs, vol. 14, pp. 135-163.

Belcher, C., and G. D. Smooker. 1934. Birds of the colony of Trinidad and Tobago. Ibis, vol. 76, pp. 572-595.

———. 1935. Birds of the colony of Trinidad and Tobago. Ibis, vol. 77, pp. 279-297.

Bond, J. 1956. Check-list of birds of the West Indies. Fourth Ed. Acad. Nat. Sci. Philadelphia, 214 pp.

———. 1958. Third supplement to the check-list of birds of the West Indies (1956). Acad. Nat. Sci. Philadelphia, 11 pp.

———. 1959. Fourth supplement to the check-list of birds of the West Indies (1956). Acad. Nat. Sci. Philadelphia, 12 pp.

———. 1962. The hypothetical element of the avifauna of Tobago. Caribbean J. Sci., vol. 2, pp. 113-118.

———. 1968. Thirteenth supplement to the check-list of birds of the West Indies (1956). Acad. Nat. Sci. Philadelphia, 12 pp.

———. 1970. Native and winter resident birds of Tobago. Acad. Nat. Sci. Philadelphia, 30 pp.

Brown, L. 1947. Birds and I. Michael Joseph, London. 200 pp.

Collins, C. 1969. A review of the shearwater records for Trinidad and Tobago, West Indies. Ibis, vol. 111, pp. 251-253.

Diamond, J. M. 1969. Avifauna equilibria and species turnover rates on the Channel Islands of California. Proc. Natl. Acad. Sci., vol. 64, pp. 57-63.

DINSMORE, J. J. 1970. Courtship behavior of the Greater Bird of Paradise. Auk, vol. 87, pp. 305-321.

———. 1970. History and natural history of *Paradisaea apoda* on Little Tobago Island, West Indies. Caribbean J. Sci., vol. 10, pp. 93-100.

DINSMORE, J. J., AND R. P. ffRENCH. 1969. Birds of St. Giles Island, Tobago. Wilson Bull., vol. 81, pp. 460-463.

DORWARD, D. F. 1962. Comparative biology of the White Booby and the Brown Booby, *Sula* spp. at Ascension. Ibis, vol. 103b, pp. 124-220.

EASTMAN, W., AND K. EASTMAN. 1959. Bird observations on Tobago. Fla. Nat., vol. 32, pp. 9-16, 52.

GILLIARD, E. T. 1969. Birds of Paradise and Bower Birds. New York, Nat. Hist. Press. 485 pp.

GOODWIN, G. G. 1961. The murine opossums (Genus *Marmosa*) of the West Indies, and the description of a new subspecies of *Rhipidomys* from Little Tobago. Amer. Mus. Novitates, no. 2070, pp. 1-20.

HERKLOTS, G. A. C. 1961. The birds of Trinidad and Tobago. Collins, London. 287 pp.

INGRAM, C. 1913. Birds of paradise in the West Indies. Avicult, Mag., vol. 20, pp. 35-41.

INGRAM, W. 1911. The acclimatization of the Greater Bird-of-Paradise (*Paradisea apoda*) in the West Indies. Avicult. Mag., vol. 18, pp. 341-351.

JARDINE, W. 1833. The naturalist's library. vol. 2. Humming-birds. Edinburgh, 166 pp.

KLEINWORT, J. 1967. Birds of Tobago. Gosse Bird Club, Broadsheet no. 9, pp. 8-9.

LOWE, P. R. 1909. Notes on some birds collected during a cruise in the Caribbean Sea. Ibis, vol. 51, pp. 304-346.

MEYER DE SCHAUENSEE, R. 1966. The species of birds of South America and their distribution. Acad. Nat. Sci., Philadelphia, 577 pp.

PHELPS, W. H., AND W. H. PHELPS, JR., 1959a. Las aves de la Isla La Orchila. Bol. Soc. Ven. Cien. Nat., no. 93, pp. 252-266.

———. 1959b. La nidificacion de las aves marinas en el archipielago de Los Roques. Bol. Soc. Ven. Cien. Nat., no. 94, pp. 325-336.

SCHREIBER, R. W., AND N. P. ASHMOLE. 1970. Seabird breeding seasons on Christmas Island, Pacific Ocean. Ibis, vol. 112, pp. 363-394.

SNOW D., AND B. K. SNOW. 1964. Breeding seasons and annual cycles of Trinidad land birds. Zoologica, vol. 49, pp. 1-35.

VAN DER WERF, P. A., J. S. ZANEVELD, AND K. H. VOOUS. 1958. Field observations on the birds of the Islas Las Aves in the southern Caribbean Sea. Ardea, vol. 46, pp. 37-58.

VOOUS, K. H. 1963. Tern colonies in Aruba, Curacao, and Bonaire, South Caribbean Sea. Proc. XIII Inter. Ornith. Congr., pp. 1214-1216.

Department of Natural Sciences, University of Tampa, Tampa, Florida 33606.

Birds of the Lluidas Vale (Worthy Park) Region, Jamaica

Alexander Cruz

During the past three years, the author has conducted investigations on the avifauna of Jamaica. Five trips were made to the island (June 14-August 17, 1969, December 20-26, 1969, April 14-May 24, 1970, June 15-July 15, 1970, and June 4-June 24, 1971). The main purpose of these visits was to study the ecology, behavior, and distribution of the Jamaican Woodpecker (*Centurus radiolatus*), but observations were also made on the total avifauna of the island. Many of the birds found on Jamaica are poorly known from the standpoint of distribution, ecology, and behavior. Therefore, the following information on the avifauna of the Lluidas Vale (Worthy Park) region, St. Catherine, Jamaica, should be instructive for future analyses.

Description

Lluidas Vale (1250 ft.) is located in an interior valley or polje. Both cockpit and tower karst are present in the area. Cockpit karst consists essentially of a succession of cone-like hills with alternating enclosed conical depressions or "cockpits." Tower karst is made up of steep-sided, forest-covered hills or mogotes (Sweeting, 1958). Each hill or group of hills is separated by a more or less flat alluvial plain that is often seasonally inundated. More or less permanent ponds and sinkholes are present at the base of the mogotes. Much of the original vegetation has been cleared from the valley, primarily for growing sugar cane, planting citrus, and raising cattle, but it is still present in the limestone mountains (Long Mountain which is an extension of the Mount Diablo Plateau) and cockpit hills surrounding the valley. Elevations vary from 1500 to 3250 ft. The vegetation of this area is classified as Wet Limestone forest (Asprey and Robbins, 1953). This type of forest is found in areas of limestone rocks where annual precipitation exceeds 75 inches and may range up to 150 inches. Many of the trees in this region have epiphytes, lianes, and bromeliads growing in profusion. Some of the characteristic trees of this community are broadleaf (*Terminalia latifolia*), Jamaican cedar (*Cedrela odorata*), sweetwoods (*Nectandra* spp.), bulletwoods (*Dipholis* spp.), various figs

(*Ficus* spp.), and many others. In the upland pastures, where much of the original vegetation has been removed, characteristic trees include guango (*Samanea saman*), large figs, prickly yellow (*Zanthoxylum martinicensis*), pimento (*Pimenta pimenta*), and trumpet tree (*Cecropia peltata*).

SPECIES ACCOUNTS

During the period of observation 87 species were recorded. Included in this count are 21 of the 24 species of land birds endemic to Jamaica and 38 of the 47 species that breed in Jamaica (Bond, 1961) but also occur elsewhere.

The following terminology is used.

Common: Found on all visits to the proper habitat, often in large numbers.

Fairly Common: Seen on a majority of visits to the proper habitat.

Uncommon: Present each year in proper habitat and season(s), but in small numbers.

Rare: Irregular occurrence in small numbers, not predictable, and overlooked or absent on many visits to the proper habitat.

Podiceps dominicus. Least Grebe; "Diving Dapper, Dabchick." Common permanent resident on freshwater ponds.

Podilymbus podiceps. Pied-billed Grebe; "Diving Dapper, Hell Diver." Fairly common permanent resident on freshwater ponds.

Butorides virescens. Green Heron; "Little Gaulin, Crabcatcher." Common permanent resident around freshwater ponds and marshy areas.

Hydranassa tricolor. Louisiana Heron; "Gaulin." Uncommon permanent resident on freshwater ponds and marshy areas.

Florida caerulea. Little Blue Heron; "Blue Gaulin, Gaulin." Uncommon permanent resident on freshwater ponds and marshy areas.

Ardeola ibis. Cattle Egret; "Cattle Gaulin." Common permanent resident, usually found in flocks among cattle.

Egretta thula. Snowy Egret; "White Gaulin, Gaulin." Uncommon permanent resident on freshwater ponds and marshy areas.

Nyctanassa violacea. Yellow-crowned Night Heron; "Night

Gaulin, Crabcatcher." Uncommon to fairly common permanent resident on freshwater ponds and marshy areas.

Cathartes aura. Turkey Vulture; "John Crow." Common permanent resident throughout the area, but more common in open areas.

Buteo jamaicensis. Red-tailed Hawk; "Chicken Hawk." Uncommon to fairly common permanent resident in the hills and upland pastures surrounding the valley.

Falco sparverius. Kestrel; "Killy Hawk, Bird Hawk." Fairly common permanent resident in cultivated areas and upland pastures.

Porzana carolina. Sora. Winter resident. An adult was observed walking over the water lilies and along the marshy edge of a small pond on April 23-25, 1970.

Porphyrula martinica. Purple Gallinule; "Coot." Common during the spring, but rare during the summer. Usually one or two individuals were observed on freshwater ponds with marshy border. Those observed during the spring were probably transients or winter residents.

Gallinula chloropus. Common Gallinule; "Coot." Common permanent resident on freshwater ponds.

Fulica americana. Coot. Fairly common during the spring of 1970 in freshwater ponds.

Jacana spinosa. Jacana; "Spanish Coot, Coot." Common permanent resident on freshwater ponds.

Charadrius vociferus. Killdeer. Fairly common transient during the spring of 1970, but also observed as late as the 21st of June 1971. Observations were on recently plowed fields and pond edges.

Columba leucocephala. White-crowned Pigeon; "Baldpate." Common permanent resident in woodlands and hills surrounding valley.

Zenaida aurita. Zenaida Dove; "Pea Dove." Common permanent resident in open to semi-open areas, especially in the roads going through the sugar cane fields and citrus areas.

Zenaida asiatica. White-winged Dove; "White-wing, Lapwing." Uncommon during the winter and spring, but very common during the summer in upland pastures. Flocks up to thirty individuals were observed.

Columbigallina passerina. Ground Dove. Common permanent resident in open and semi-open areas.

Leptotila jamaicensis. White-bellied Dove; "White-belly." Uncommon to fairly common permanent resident in undergrowth of forested areas, occasionally occurring in more open areas.

Geotrygon montana. Ruddy Quail Dove; "Partridge." Uncommon to fairly common resident of the undergrowth of forested areas and forest edges.

Geotrygon versicolor. Crested Quail Dove; "Mountain Witch." Rare to uncommon resident of undergrowth in forested areas, usually allowing close approach before flying and then flying only a short distance.

Amazona collaria. Yellow-billed Parrot. Uncommon permanent resident in the hills and mountains (Long Mountain) surrounding the valley, but may be more common since many flocks of unidentifiable parrots were observed flying.

Amazona agilis. Black-billed Parrot. Uncommon to fairly common resident of the Long Mountain area. Usually observed flying or perched in small flocks of 2 to 6 individuals.

Aratinga nana. Olive-throated Parakeet. Common permanent resident in wooded and semiwooded areas. Roosting flocks numbering thousands of birds were observed.

Forpus passerinus. Guiana Parrotlet. Common permanent resident in upland pastures and wooded hills.

Hyetornis pluvialis. Chestnut-bellied Cuckoo; "Old Man Bird." Fairly common in upland pastures and forested areas.

Saurothera vetula. Jamaican Lizard Cuckoo; "Rain Bird." Uncommon permanent resident. More partial to wooded areas than the preceding species, and more often heard than seen.

Crotophaga ani. Smooth-billed Ani; "Tick Bird, Black Bird." Common permanent resident in open areas, especially pastures.

Tyto alba. Barn Owl; "White Owl, Screech Owl, Potoo." Uncommon permanent resident. Often observed flying over the pastures and cane fields at dusk. One individual roosted during the day in River Sink Cave at Worthy Park. Owl pellets obtained from this cave showed that rats (*Rattus*) form a principal item in its diet.

Pseudoscops grammicus. Jamaican Owl; "Brown Owl, Potoo." Rare to uncommon permanent resident, but may be more common

since its nocturnal habits make it difficult to find. One individual roosted during the day in Swansea Cave at Worthy Park.

Nyctibius griseus. Common Potoo. Apparently rare, but may be more common since its nocturnal habits make it difficult to observe. Seen on two different occasions (7 May and 1 July 1970), when it was sitting upright on fence post in cattle pasture area.

Chordeiles minor. Common Nighthawk; "Mosquito Hawk." Uncommon summer resident. Usually observed flying towards sunset and on cloudy days.

Streptoprocne zonaris. Collared Swift; "Rain Bird." Fairly common permanent resident, often observed flying at dusk and on cloudy days.

Cypseloides niger. Black Swift; Black Swallow, Swallow, Rain Bird." Uncommon permanent resident, observed under the same conditions as the Collared Swift.

Tachornis phoenicobia. Antillean Palm Swift; "Swallow." Common permanent resident in open to semiopened areas. Often observed flying during the day.

Anthracothorax mango. Jamaican Mango; "Doctor Bird, Hummingbird." Fairly common resident in open and semiopened situations.

Trochilus polytmus. Streamertail; "Doctor Bird, Hummingbird." Common permanent resident throughout the region.

Mellisuga minima. Vervain Hummingbird; "Bee Hummingbird." Fairly common permanent resident throughout the region.

Todus todus. Jamaican Tody; "Robin Redbreast." Common permanent resident in wooded pastures and limestone hills surrounding the valley.

Centurus radiolatus. Jamaican Woodpecker. Common permanent resident in wooded and semiwooded areas.

Sphyrapicus varius. Yellow-bellied Sapsucker. Uncommon winter resident in wooded and semiwooded areas.

Platypsaris niger. Jamaican Becard; "Tom Fool.' Uncommon permanent resident in wooded and semiwooded areas.

Tyrannus dominicensis. Gray Kingbird; "Petchary." Common summer resident in open and semiopened areas, often near human habitations.

Tyrannus caudifasciatus. Loggerhead Kingbird; "Petchary." Common permanent resident in upland pastures and wooded areas.

Myiarchus stolidus. Stolid Flycatcher; "Tom Fool." Uncommon permanent resident, the rarest of the *Myiarchus* flycatchers in the Lluidas Vale region. Observed in upland pasture areas.

Myiarchus barbirostris. Dusky-capped Flycatcher; "Little Tom Fool." Fairly common permanent resident in upland pastures and wooded areas.

Myiarchus validus. Rufous-tailed Flycatcher; "Big Tom Fool." Fairly common permanent resident in upland pastures and wooded areas.

Contopus caribaeus. Greater Antillean Pewee; "Little Tom Fool." Common permanent resident in upland pastures and wooded areas.

Hirundo rustica. Barn Swallow. Common spring transient. Flocks numbering hundreds of individuals observed flying over recently plowed fields.

Petrochelidon fulva. Cave Swallow. Common permanent resident. Occurring throughout the area, but more common in open and semi-open areas. Breeding in caves and depressions in the limestone hills.

Corvus jamaicensis. Jamaican Crow; "Jabbering Crow." Common in upland pastures and limestone hills. Small flocks of 3-4 individuals were usually seen.

Mimus polyglottos. Northern Mockingbird; "Nightingale." Common permanent resident in open and semi-open areas, often near human habitations.

Dumetella carolinensis. Catbird. Uncommon winter resident. Observed in dense undergrowth in upland pasture area.

Turdus jamaicensis. White-eyed Thrush; "Glass Eye." Fairly common permanent resident in wooded pastures and hills.

Turdus aurantius. White-chinned Thrush; "Hopping Dick." Common permanent resident, more partial to open areas than preceding species.

Myadestes genibarbis. Rufous-throated Solitaire; "Fiddler." Uncommon during the winter and spring. No individuals were recorded during the summers of 1969, 1970, and 1971. Possibly this species undergoes a vertical migration as has been observed by Kidd (1964).

Sturnus vulgaris. Starling. Fairly common in upland pastures, where flocks of up to 30 individuals were observed.

Vireo modestus. Jamaican White-eyed Vireo; "Sewi-sewi." Uncommon to fairly common permanent resident in wooded and semiwooded areas.

Vireo altiloquus. Black-whiskered Vireo; "John Chewitt." Common summer resident in semiwooded and wooded areas.

Vireo osburni. Blue Mountain Vireo. Uncommon permanent resident in wooded areas.

Mniotilta varia. Black-and-white Warbler; "Ant Bird." Common winter resident in wooded and semiwooded areas.

Helmitheros vermivorus. Worm-eating Warbler. Uncommon winter resident of undergrowth in wooded and semiwooded areas.

Parula americana. Parula Warbler. Common winter resident in wooded and semiwooded areas.

Dendroica magnolia. Magnolia Warbler. Uncommon winter resident in wooded and semiwooded areas.

Dendroica tigrina. Cape May Warbler. Fairly common winter resident in wooded and semiwooded areas.

Dendroica caerulescens. Black-throated Blue Warbler. Common winter resident in wooded and semiwooded areas.

Dendroica virens. Black-throated Green Warbler. Uncommon to fairly common winter resident in wooded and semiwooded areas.

Dendroica striata. Black-poll Warbler. Uncommon spring transient in wooded and semiwooded areas.

Dendroica pharetra. Arrow-headed Warbler; "Ant Bird." Uncommon to fairly common permanent resident of forested areas and forest edges.

Seiurus aurocapillus. Ovenbird. Uncommon winter resident in undergrowth of wooded areas.

Setophaga ruticilla. American Redstart. Common winter resident in wooded and semiwooded areas.

Coereba flaveola. Bananaquit; "Beanie Bird." Common permanent resident. Found throughout the region, but more common in semi-open areas and near human habitations.

Euneornis campestris. Orangequit; "Swee." Common permanent resident in wooded and semiwooded areas and especially common in citrus groves.

Pyrrhuphonia jamaica. Jamaican Euphonia; "Blue Quit." Common permanent resident in wooded and semiwooded areas, but often found near human habitations.

Spindalis zena. Stripe-headed Tanager; "Goldy, Goldfinch." Fairly common permanent resident in forested areas and forest edges, including citrus groves.

Piranga olivacea. Scarlet Tanager. Uncommon spring transient in wooded and semiwooded areas.

Quiscalus niger. Greater Antillean Grackle; "Cling-cling." Uncommon to fairly common, occurring around human habitations and pastures.

Icterus leucopteryx. Jamaican Oriole; "Auntie Katie." Common resident in wooded and semiwooded areas. Occasionally observed near human habitations.

Icterus galbula. Baltimore Oriole. Rare spring transient, one male observed on 10 and 11 May 1970 in upland pasture area.

Sicalis flaveola. Saffron Finch; "Canary." Fairly common permanent resident, occurring in semiwooded areas, upland pastures, and gardens.

Loxigilla violacea. Greater Antillean Bullfinch; "Black Sparrow." Fairly common permanent resident in wooded and semiwooded areas.

Tiaris olivacea. Yellow-faced Grassquit; "Grassquit." Common permanent resident in open and semi-open areas.

Tiaris bicolor. Black-faced Grassquit; "Grassquit." Permanent resident, not as common as the Yellow-faced Grassquit, but occurring in the same areas.

Loxipasser anoxanthus. Yellow-shouldered Grassquit; "Yellowback." Uncommon permanent resident in wooded and semiwooded areas.

Ammodramus savannarum. Grasshopper Sparrow. Fairly common permanent resident of pasture areas.

ACKNOWLEDGMENTS

Support during this investigation came from a National Institute of Health Grant awarded to Dr. T. H. Patton and from a Frank M. Chapman Grant awarded to the author. A number of persons assisted in field work and participated in helpful discussion of this project, particularly Philip Clarke, Dr. David W. Johnston, Dr. Thomas H. Patton, and Michael Winegar. C. Bernard Lewis, Director of the Institute of Jamaica, was very helpful and made the

facilities of the Institute available to me. The Clarke family of Worthy Park Estate not only provided strategic lodging, but their friendly hospitality made the visits more pleasant.

LITERATURE CITED

ASPREY, G. F., AND R. G. ROBBINS. 1953. The vegetation of Jamaica. Ecol. Mon., vol. 23, no. 2, pp. 359-412.

BOND, JAMES. 1961. (Field guide to) Birds of the West Indies. Houghton Mifflin Co., Boston, 256 pp. 8 pl., 186 figs.

KIDD, E. R. G. 1964. Hillbirds at low altitudes at Mona Reservoir. Goose Bird Club, Broadsheet No. 2, p. 9.

SWEETING, M. M. 1958. The karstlands of Jamaica. Geographical Jour., vol. 124, part 2, pp. 184-201.

Department of Zoology and Florida State Museum, University of Florida, Gainesville, Florida 32601.

Quart. Jour. Florida Acad. Sci. 35(1) 1972

FLORIDA ACADEMY OF SCIENCES

Institutional Members for 1972

American Medical Research Institute

Archbold Expeditions

Barry College

Florida Atlantic University

Florida Institute of Technology

Florida Presbyterian College

Florida Southern College

Florida State University

Florida Technological University

Jacksonville University

Manatee Junior College

Marymount College

Miami-Dade Junior College

Mound Park Hospital Foundation

Ormond Beach Hospital

Rollins College

St. Leo College

Stetson University

University of Florida

University of Florida
Communications Sciences Laboratory

University of Miami

University of South Florida

University of Tampa

University of West Florida

FLORIDA ACADEMY OF SCIENCES

Founded 1936

OFFICERS FOR 1972

Membership applications, subscriptions, renewals, changes of address, and orders for back numbers should be addressed to the Treasurer

---

Correspondence regarding exchanges should be addressed to

Gift and Exchange Section, University of Florida Libraries
Gainesville, Florida 32601

Quarterly Journal
of the
Florida Academy of Sciences

Vol. 35 April 1972 Supplement to No. 1

PROGRAM

of the
THIRTY SIXTH ANNUAL MEETING

of the Academy in conjunction with the
FLORIDA JUNIOR ACADEMY OF SCIENCES
FLORIDA SCIENCE AND ENGINEERING FAIR
FLORIDA STATE SCIENCE TALENT SEARCH
and Florida Section meetings of
THE AMERICAN ASSOCIATION OF PHYSICS TEACHERS
THE OPTICAL SOCIETY OF AMERICA

Rollins College, Winter Park, Florida April 6, 7, 8, 1972

General Information 1
Ladies Program 1
Chronological Program of Events 2
Section Programs 4
Biological Sciences 4, 29
Physical Sciences 16, 35
Medical Sciences 28, 35
Conservation 21, 29
Social Sciences 23, 28
Science Teaching 25
General Interest Sessions 28
Public Symposia 28
Addiction - Drugs and Alcohol 28
Biological Effects of Electrical Power Generation. . 29
Clean Air Technology for Surgery, Science and Industry 35
Special Lectures 36
The Space Frontier 36
Pocket Fourier Spectroscopy 37
Global Earth Control Satellite Net 21
Sessions of Associated Florida Sections of:
American Association of Physics Teachers 37
Optical Society of America 37
Florida State Science Talent Search 37
Junior Academy of Science Program 39
Map - Back Cover

QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

Editor: Pierce Brodkorb

The Quarterly Journal welcomes original articles containing significant new knowledge, or new interpretation of knowledge, in any field of Science. Articles must not duplicate in any substantial way material that is published elsewhere.

INSTRUCTIONS TO AUTHORS

Rapid, efficient, and economical transmission of knowledge by means of the printed word requires full cooperation between author and editor. Revise copy before submission to insure logical order, conciseness, and clarity.

MANUSCRIPTS should be typed double-space *throughout*, on one side of numbered sheets of 8½ by 11 inch, smooth, bond paper.

A CARBON COPY will facilitate review by referees.

MARGINS should be 1½ inches all around.

TITLES must not exceed 55 characters, including spaces.

FOOTNOTES should be avoided. Give ACKNOWLEDGMENTS in the text and Address in paragraph form following Literature Cited.

LITERATURE CITED follows the text. *Double-space* and follow the form in the current volume. *For articles* give title, journal, volume, and inclusive pages. *For books* give title, publisher, place, and total pages.

TABLES are charged to authors at $20.00 per page or fraction. Titles must be short, but explanatory matter may be given in footnotes. Type each table on a separate sheet, *double-space, unruled,* to fit normal width of page, and place after Literature Cited.

LEGENDS for illustrations should be grouped on a sheet, *double-spaced,* in the form used in the current volume, and placed after Tables. Titles must be short but may be followed by explanatory matter.

ILLUSTRATIONS are charged to authors ($17.00 per page or fraction). DRAWINGS should be in India ink, on good board or drafting paper, and lettered by lettering guide or equivalent. Plan linework and lettering for reduction, so that final width is 4⅛ inches, and final length does not exceed 6⅝ inches. Do not submit illustrations needing reduction by more than one-half. PHOTOGRAPHS should be of good contrast, on glossy paper. Do not write heavily on the backs of photographs.

PROOF must be returned promptly. Leave a forwarding address in case of extended absence.

REPRINTS may be ordered when the author returns corrected proof.

Published by the Florida Academy of Sciences

Printed by the Storter Printing Company

Gainesville, Florida

GENERAL INFORMATION

All registrants for the Junior or Senior Academy meetings are welcomed to all technical sessions of both the junior and senior academies, to the Science Talent Search, the Science and Engineering Fair, the Academy Friday luncheon and the Junior Academy Banquet. Guests of registrants are also welcomed to the luncheon, but to the banquet on only a limited basis. The medalist's address and business meeting following the luncheon may be attended without attending the luncheon. The sessions of the Florida sections of the American Association of Physics Teachers and the Optical Society of America are open to all interested, and their members are welcome at the sessions of the Academy. Non-registrants are invited to the public symposia and panels on Thursday night and Saturday.

Registration

Registration for the Senior Academy will be in the foyer of the south entrance to the Bush Science Center during the following hours:

Thursday	2:00 pm - 5:30 pm
Friday	8:00 am - 5:00 pm
Saturday	8:00 am -10:00 am

Registration for the Junior Academy will be in the foyer of the north entrance to the Bush Science Center.

Academy Luncheon

A buffet luncheon will be served commencing at 11:45 am Friday in the Rose Skillman Dining Hall followed shortly after 12:30 in the same room by the Annual Business Meeting and the address of The 1972 Academy Medalist. The price of the luncheon is $3.00. It is possible to serve individuals only if they reserve places by March 27. A reservation form is enclosed for your convenience.

Junior Academy Banquet

A buffet banquet will be served commencing at 5:45 pm in the Rose Skillman Dining Hall.

Lodging

Lodging needs to be reserved as far in advance as possible and will be extremely difficult to obtain in April. Suggestions on motels were sent with the call for papers. The Local Arrangements Chairman can give some help with group accommodations for students.

Parking — According to map on rear cover.

Commercial Exhibits -- Rooms 119 and 123 Bush Science Center.

Ladies Program

A tour of Disney World is scheduled for Friday, April 7th. Chartered buses will leave the A. G. Bush Science Center at 9:00 am. This tour will be approximately eight hours. Seven Disney attractions will be included in the price of $6.50. Lunch will be up to the individual at the Disney World complex.

Saturday, April 8th will be a special ladies day program of the Winter Park area. It will consist of:

9:30 am	Guided tour of the A. G. Bush Science Center
10:30 am	Guided tour of the Beal Shell Museum
11:30 am	Guided tour of the Morse Gallery
1:00 pm	Lunch break
2:00 pm	A boat tour of the Winter Park chain of lakes, ($1.00)

CHRONOLOGICAL PROGRAM OF EVENTS

	WEDNESDAY APRIL 5, 1972	
10 am to 9 pm	Registration and set up of Exhibits for Science Fair	Enyart Field House
	THURSDAY APRIL 6, 1972	
9:30 am	Science Fair Judges Meeting	Crummer Auditorium
10 am to 6 pm	Science Fair Judging (Fair Closed to the Public)	
2:00 pm	Illustrated Lecture: The Space Frontier	108 Bush Pg. 36
2:30 pm	Executive Council Meeting	134 Bush
6:30 pm	Executive Council Dinner	
6 - 10 pm	Florida Science and Engineering Fair	Enyart Field House
8:00 pm	PUBLIC SYMPOSIUM: Addiction - Drugs and Alcohol Medical and Social Sciences Sections	Bush Auditorium Pg. 28
	FRIDAY APRIL 7, 1972	
8:30 am to 5 pm	Florida State Science Talent Search	
	Biological Sciences	207 Bush
	Physical Sciences	210 Bush
	(28 papers: detailed program available at FAS registration desk)	
9:00 am	Regular Meeting FFFS - Board of Directors Regional and Local Directors, Regular and Committee Members, Science Teachers and Coordinators invited. Public Welcome	222 Crummer
9:00 am	Florida Junior Academy of Science	
	Junior High Research Papers	108 Bush Pg. 39
	Senior High Literary Research Papers	Bush Auditorium Pg. 39
9:00 am to 5 pm	Florida Science and Engineering Fair	Enyart Field House

	TECHNICAL SESSIONS	
8:30 am	Biological Sciences Section,A	326 Bush Pg. 4
8:30 am	Biological Sciences Section, B	328 Bush Pg. 7
9:00 am	Physical Sciences Section	114 Bush Pg. 16
9:00 am	Conservation Section	325 Bush Pg. 21
9:00 am	Social Sciences Section	308 Bush Pg. 23
9:00 am	Science Teaching Section	301 Bush Pg. 25
11:00 am	Junior Academy Sponsor's Meeting	134 Bush
11:45 am	Academy Annual Luncheon (Reservations required)	Skillman Dining Hall
12:30 pm	Welcome to Rollins College	
12:40 pm	1972 Medalist's Address	
1:10 pm	Academy Business Meeting	
1:00 pm	Florida Junior Academy General Session	Bush Auditorium Pg. 40
1:15 pm	Highschool Experimental Research Papers	Bush Auditorium Pg. 40
2:00 pm	TECHNICAL SESSIONS	
	Biological Sciences Section,A	326 Bush Pg. 10
	Biological Sciences Section,B	328 Bush Pg. 13
	Physical Sciences Section	114 Bush Pg. 18
	American Association of Physics Teachers	107 Bush Pg. 36
	Social Sciences Section	308 Bush Pg. 23
	Science Teaching Section	301 Bush Pg. 25
6:00 pm	Junior Academy Banquet (Senior Academy welcomed) (Reservations required)	Skillman Dining Hall
7:00 pm	Social period (Senior Academy)	Langford Hotel
8:00 pm	Awards Assembly: Fair, Talent Search, Junior Academy	Knowles Memorial Chapel

SATURDAY APRIL 8, 1972

7:30 - 12 am	Removal of Science Fair Exhibits	
8:15	PUBLIC TECHNICAL SYMPOSIUM Biological Effects of Electrical Power Generation I, Biological Sciences and Conservation Sects.	108 Bush Pg. 29
8:30 am	Physical Sciences Section	326 Bush Pg. 20
9:00 am	Optical Society of America	328 Bush Pg. 37
11:00 am	Special Lecture: Pocket Fourier Spectroscopy; Optical Society of America, American Association of Physics Teachers, and Physical Sciences Section	Bush Auditorium Pg. 37
1:30 pm	PUBLIC SYMPOSIUM Clean Air Technology for Surgery, Science and Industry, Medical and Physical Sciences Sections	Bush Auditorium Pg. 35
2:00 pm	PUBLIC TECHNICAL SYMPOSIUM Biological Effects of Electrical Power Generation II, Biological Sciences and Conservation Sections.	108 Bush Pg. 32
2:00 pm	Optical Society of America	328 Bush Pg. 37

BIOLOGICAL SCIENCES SECTION

Friday 8:30 A.M., Session A
R. W. Long (University of South Florida) presiding

BS-1 Ordinal records for Florida fungi. B.R. POHLAD, DON R. REYNOLDS, Florida Technological University.

8:45
BS-2 Microbial Ecology of Vascular Aquatic Plants.* BETTY OAKS, W.S. SILVER, R.L. MANSELL, University of South Florida.--As a preliminary to finding microbes which might be useful in controlling noxious aquatic weeds, a study is being made of the autochthonous flora of Eichhornia and Hydrilla. The effect of selection site, season and other environmental conditions on the microflora will be discussed.

*Research supported by NSF GY-9180, SWFWMD and Florida Department of Natural Resources.

9:00
BS-3 Effects of Irradiation on Fecal Coliform, M-Pyogenis, and M-Smegmatis Bacteria. DAVID D. WOODBRIDGE, WILLIAM R. GARRETT, ROBERT F. RICHMOND, PRISCILLA C. COOPER, Florida Institute of Technology.--Destruction of bacteria without chemical contamination of water is of prime importance in man's fight against pollution. Under a contract with the U.S. Army Corps of Engineers, U.C.P.R. has found that the degree of kill of bacteria is a function of the dissolved oxygen in the carrier solution as well as the radiation dosages. Results are present of the effectiveness of irradiation on three different bacteria at various levels of dissolved oxygen.

9:15
BS-4 Vegetational Changes in the National Key Deer Refuge - III. TAYLOR R. ALEXANDER, JOHN D. DICKSON III, University of Miami.--This study of a pineland area measures the effect of mechanical cutting and removal of vegetation with a bulldozer as a substitute for fire to maintain deer browse plants. Field work was done 28 months after bulldozing. Data from 50 quadrats show good recovery of woody pineland species and an increase in herbaceous species used by deer. Deer use of the cleared area is heavy.

9:30
BS-5 Ethnobotany of Chokoloskee Island, Florida. DANIEL F. AUSTIN, DAVID MACJUNKIN, Florida Atlantic University.--Floristic and historical studies were made to determine man's prehistoric and historic effects on the vegetation of Chokoloskee Island. Particular emphasis has been placed on ethnic plant residuals, stands modified aboriginally and colonially, and recently naturalized exotics. The current destructive impact of residents and tourists on the ecology of the island will be described and illustrated. Our study indicates that most, if not all, vegetation on the island is experiencing secondary succession. The island flora contains 40% ethnic plants, 40% strand plants, and 20% classified as other (i.e. native, etc.).

9:45
BS-6 Nutrient Relationships in Mature and Fire Damaged Stands of Sawgrass. K.K. STEWARD, W.H. ORNES, R.E. ELLISTON, PSRD, ARS, USDA, Ft. Lauderdale, Florida.--Levels of nitrogen, phosphorus and potassium in the tissue of plants from mature unburned stands of sawgrass remained constant from month to month. This indicated that levels in the tissue did not change with increased age of the tissue. The levels of these nutrients were initially higher in young tissue of plants regrowing after fires than in plants from unburned mature stands. The highest levels in young tissue occurred immediately after the fires and decreased over a three month period to levels similar to those in plants from mature stands. The concentrations of the nutrients in mature sawgrass stands were at the extreme low end of the range of previously reported values for Everglades vegetation. These values expressed as percent of oven dry plant weight were 0.5 to 0.7% nitrogen, 0.03 to 0.04% phosphorus and 0.5 to 0.7% potassium. Soil contents of these nutrients were also low. Low nutrient levels in both soil and plants indicated that sampling sites were infertile.

10:00
BS-7 Leaf Morphology in the Systematics of Chamaesyce (Euphorbiaceae) of South Florida.* C.P. SREEMADHAVAN, University of South Florida.--This paper will explore the possibility of using the following characters of the leaf for recognition of specific and infraspecific taxa of *Chamaesyce* S.F. Gray: (1) Size, shape, nature of the margin, apex, and base; (2) Major and minor venation patterns; (3) Types of stomata; (4) Size, shape, and arrangement of epidermal cells in relation to epidermal appendages; and (5) Epidermal appendages. Reexamination leading to probable reassignment of the following taxa is recommended: *Chamaesyce ammanioides*, *C. cumulicola*, the three varieties of *C. porteriana* and the infraspecific taxa of *C. deltoidea*.

*Research supported by NSF.

10:15
BS-8a An Investigation of the Stomatal Apparatus of Certain Bahamian Flora.* BRUCE D. JACKSON, Miami-Dade Junior College, North.--Abaxial and adaxial surfaces of Bahamian plants[1] were investigated as to (1) frequency and size of guard cells; (2) subsidiary cell patterns; (3) presence of outstanding epidermal appendages. Preliminary data reveal that plant families have particular subsidiary cell patterns which would indicate that these patterns may be used as a diagnostic tool.

*This paper was part of a directed individual research study under Professor Harold Yaffa, Miami-Dade Junior College, North.

[1]The plants used in this research were generously provided by Fairchild Tropical Garden, Miami, Florida.

10:30
BS-8b The Phosphorus Nutrition of Hydrilla. K.K. STEWARD, PSRD, ARS, USDA, Ft. Lauderdale, Florida.--(*Hydrilla verticillata* Casp.) was cultured from vegetative propagules in nutrient solutions containing a range of

phosphorus (P) concentrations to study the P requirements of this aquatic plant. The dry weight, total P accumulation and bicarbonate utilization of plants increased with increased concentration of P in solutions and with time. Bicarbonate utilization was directly related to increase in plant dry weight. The levels of P in tissue were proportional to concentration of P in solutions but decreased with time regardless of solution concentration. The total P content of plants grown without added P remained constant through seven weeks of growth. The P reserves in the propagules of these plants were sufficient to produce a dry matter yield of 1127 mg after 50 days. The addition of 1.7 mg P produced a 57% increase in yield over the same time period. The results of these experiments suggest that hydrilla has a low requirement for P.

10:45

BS-9 Preliminary Biochemical Studies of the Effect of Diquat on Hydrilla verticillata.* R.E. WOODWARD, R.L. MANSELL, W.S. SILVER, University of South Florida.--Hydrilla populations in three Hillsborough County lakes were sprayed with diquat by the bivert system. Observations were made on the subsequent physical changes which occurred in each site. Samples were collected and analyzed for changes in flavanoid and phenolic acid composition.

*Research supported by SWFWMD and Florida Department of Natural Resources.

11:00

BS-10 Qualitative Analysis of Phenolic Compounds in Eichornia crassipes.* D.E. KING, R.L. MANSELL, University of South Florida.--Qualitative analysis was done on leaves and flowers of naturally occurring populations of E. crassipes. The flavonoid constituents, phenolic acids and their derivatives were analyzed. A total of three falvonoid compounds were found to exist in abundance and both free and esterified cinnamic and benzoic acid components were identified.

*Research supported in part by an NSF Grant GY-9180.

11:15

BS-11 Analysis of Phenylalanine-ammonia-lyase activity and anthocyanin biosynthesis in developing flower petals of Impatiens balsamina L. SUZANNE MRAS, R.R. HARRELL, JR., R.L. MANSELL, University of South Florida.--The activity of phenylalanine-ammonia-lyase and the concentration of anthocyanin pigment was determined in seven different stages of development in flower tissue. The results show that the major synthesis of pigment begins during the middle stages of development and ceases before maturation of the tissue. Enzyme activity closely parallels the appearance of pigment. The significance of this enzyme and its role in anthocyanin biosynthesis will be discussed.

11:30

BS-12 Para-Coumaric Acid Hydroxylase Activity in Flower Petals of Impatiens balsamina. DESTINY TOLEDO, R.L. MANSELL, University of South Florida.--Acetone powders of I. balsamina flower tissue yielded active preparations of p-coumaric acid hydroxylase. The activity of this enzyme has been determined in four different stages of flower development. The possible role of this enzyme in the biosynthesis of anthocyanins in this tissue will be discussed.

11:45
BS-13 The fine structure of Nocardia polychromogenes as revealed by scanning and transmission electron microscopy.* C.S. HUANG, Chipola Jr. College, G.E. MICHAELS, University of Georgia.--This paper will describe the morphological characteristics of Nocardia. The cell growth of N. polychromogenes on both Carbon Utilization Agar (CUA) and Nutrient Broth plus 2% Yeast Extract (NBTE) were studied by scanning and transmission electron microscopy (SEM & TEM). A 2% osmium tetraoxide was used to fix the isolated colonies for SEM studies. Haystacked colonies with three bands around the cylindrical arthrospores were found in N. polychromogenes. The relationship between hyphael segmentation, fragmentation, and colonial structure were revealed by SEM micrographs of N. asteroides. For TEM studies, the cells were fixed by a modification of the procedure outlined by Kellenberger. The cells were dehydrated in ethyl alcohol, cleared in propylene oxide, and embedded in maraglass. Thin sections of the bacteria were grown on NBYE for 36 hr and revealed the complex relationship between vesicular mesosomes and transverse septum formation. Multiple and irregular septation were found in 48 cultures.

*Research supported by NSF Grant GY-8550.

BIOLOGICAL SCIENCES SECTION

Friday, 8:30 A.M. Session B, Room 328
F. E. Friedl (University of South Florida) presiding
8:30
BS-14 Mesenterial Filaments from Manicina areolata (Linn.). RAYMOND K. DUROS, University of Miami.--A brief study of the elongate filaments abundantly extruded by the Common Rose Coral, M. areolata, and the nematocyst capsules contained in them. Somewhat detailed descriptions of the filaments and of the contained capsules are given. The latter constitute two rather distinct types of specialized nematocysts, namely holotrichs and microbasic p-mastigophores. Their discharge, probable functions, and importance in coelenterate taxonomy are briefly reviewed.

8:45

BS-15 Preliminary notes on the sexual maturity and fecundity of Idotea metallica, BOSC (Crustacea, Isopoda). F.E. PITTS, S.B. COLLARD, University of West Florida.--Idotea metallica is a pelagic species of marine Isopod, about which very little specific ecology has been reported. Approximately 1000 specimens were captured by Dr. S.B. Collard in May, 1969, from the Mediterranean Sea while aboard the R/V Atlantis II owned by Woods Hole Oceanographic Institution. The specimens were taken with neuston tows on transects from the Island of Rhodes to Naples. The laboratory study of the samples consisted of noting the relationships between size of the female and fecundity, and between specimen size and apparent sexual maturity. It was found that the numbers of eggs per gravid female were not necessarily dependent on the numbers and types of factors involved. It was also found that the sexes could be distinguished in younger specimens than previously reported. Further, some specimens of both male and female were found to be somewhat larger than sizes previously reported.

9:00

BS-16 Some Aspects of the Development of Clypeaster rosaceus. CHARLES N. D'ASARO.--In an effort to determine the developmental origin of the irregular characters of Clypeaster rosaceus, this species was cultured for two months. The larvae were short-term planktotrophs and completed metamorphosis in one week. Post-larvae were reared until they were recognizable as clypeasteroids. The complete ontogeny was outlined up to that point; and it was shown that the irregular characters arose days after metamorphosis. Certain unexpected facts relating to the juvenile's habits were discovered.

9:15

BS-17 Reproductive periodicity and gametogenesis in a sand dollar, Mellita quinquiesperforata, population near Tampa Bay, Florida. JACQUELENE MOSS, University of South Florida.--The spawning time of a population of the sand dollar, Mellita quinquiesperforata, was determined using four different approaches: gonadal index, histological examination of gonads, appearance of larvae in the plankton, and appearance of young in the bottom. From gonad index, spawning appeared to begin in spring and end in early summer. From appearance of larvae in the plankton and appearance of young, a major spawning period appears to take place during spring, proceeding to a lesser degree throughout summer and early fall. Histological sections of gonads showed that Mellita became reproductively mature at one year of age and young animals spawn earlier than older ones. Yearly comparisons indicate water temperature as well as age composition of the adult population influence beginning of spawning as well as duration. The population is not synchronous.

9:30

BS-18 Histological Analysis of Neurosecretory Granules in Spinulosida and Platyasterida (Echinodermata:Asteroidea). D.G. ATWOOD, University of South Florida.--Neurosecretory granules were demonstrated in nervous tissues of 3 asteroids (Echinaster echinophorus, Luidia clathrata and Patiria miniata) using five common neurosecretory staining procedures. Fuchsinophilic granules existed within the sensory and motor nervous elements of the radial nerve and tube feet, as well as in sensory regions of the body epidermis and cardiac stomach. No granules were found in the extensive nervous plexus of the oral and aboral walls and Tiedemann's diverticulum of the pyloric caeca. Fuchsinophilic substances within sensory elements ranged in diameter size from diffuse particles to 2.0 microns, whereas granules within motor tissues ranged from diffuse particles to 1.0 microns.

9:45

BS-19 Dissodactylus: A Commensal (?) Crab. DANA BETH TYLER, University of West Florida.--The biological relationships between the pinnotherid crab genus Dissodactylus and its various echinoderm hosts was investigated. The ingestion of host tissue by the crab, possibly as an energy or nutrient source, was tentatively demonstrated. It is hoped to more conclusively show this by using histochemical techniques and dietary experiments. Larval relationships to the host were also investigated.

10:15

BS-20 Anoxic Capacity of Glottidia pyramidata (Stim.) Dall, (Brachiopoda: Inarticulata). J.H. SCHMIDT, University of South Florida.--Groups of from 10 to 20 organisms were subjected to zero oxygen tensions in filtered seawater in complete darkness for varying time periods up to 12 days. Juveniles were able to withstand anoxia for up to 8 days with no mortality. Adults could only withstand 48 hours of anoxia without considerable mortality.

Juveniles adapted to an anaerobic environment for 4 days and aerobicly adapted juveniles were placed in Warburg flasks. Their oxygen consumption rates were determined under identical conditions. Anerobicly adapted animals consumed oxygen at an average rate of 103.2ul/g (dry wt.) per hour. Aerobicly adapted animals consumed oxygen at an average rate of 48.8ul/g (dry wt.) per hour.

Deposition of a black pigment was noted during anaerobiosis in the tissues of both juvenile and adult organisms. It was seen to disappear from juveniles on return to an aerobic environment.

10:30

BS-21 Indications of anaerobiosis in Anthopleura krebsii Duchassaing and Michelotti, and intertidal sea anemone. H.S. BOLTON, University of South Florida.--Anthopleura krebsii has been observed to exist unsubmerged for extended periods of time. Since the animal appears to be inactive at these times, one might ask if its oxygen uptake decreases and if in fact the animal maintains its metabolic functions at greatly reduced rates.

In studies on its respiratory rate, it was noted that, in the dark with oxygen displaced from its seawater environment by nitrogen, A. krebsii can exist for at least 14 days. Oxygen in this closed system was undetectable using the Winkler method.

Since oxygen is used when available, alternate respiratory pathways are suggested. Schemes similar to those already described for the nematode, Ascaris, and other invertebrates could be operable in this anemone.

10:45

BS-22 The sertoli cell-spermatozoan relationship in the teleost Poecilia latipinna.* H. GRIER, University of South Florida.--An ultrastructural investigation of the testis of Poecilia latipinna indicates that Sertoli cells serve a supportive function for mature sperm as has been described in higher vertebrates. The Sertoli cells of this teleost also ingest the cytoplasmic remnant cast off by the spermatozoa during spermiogenesis. Ingestion of the cytoplasmic remnants of sperm is characterized by increased lysosomal activity on the part of the Sertoli cell.

*Research supported by a Grant-in-Aid of Research by the Society of the Sigma Xi.

11:00

BS-23 Pituitary eta cell function in embryos and juveniles of the teleost Poecilia latipinna. H. GRIER, University of South Florida.

11:15
BS-24 Genetic factors affecting pupation site in laboratory stocks of Drosophila melanogaster. JAMES P. MATTESON, JOHN R. BAYLIS, JR., University of West Florida.--Differences between laboratory stocks of Drosophila melanogaster in the location of pupae was observed. In some stocks all pupae were located relatively close ($<$5 cm) to the food. In other stocks many of the pupae were located a greater distance ($<$8 cm) from the food. Crosses were made between "high" and "low" stocks and carried through several generations. The results of these crosses indicate that pupation site differences are under the control of polygenes.

11:30
BS-25 Courtship behavior and evidence for a sex attractant in the Caribbean fruit fly. JAMES L. NATION, University of Florida.--Males of Anastrepha suspensa (Loew.) court and attract females. Courting males distend the pleural region of the abdomen to form a small bubble or puff on each side and may also evert a pouch of cuticle surrounding the anal area. The wings may be vibrated rapidly at intervals during the puffing behavior. Males can attract females in a laboratory bioassay over a distance of 10 inches. Percent attraction data for different ages of males and females will be shown. Up to 50% of the virgin females in a laboratory test can be attracted at 11 days of age. Attraction is less for flies that are younger or older than this age. Mated females are still attracted to males, though in smaller numbers than virgin females. Glands suspected of producing a pheromone have been found in males.

11:45
BS-25a The Destruction of Red Mangrove Prop Roots by the Wood Boring Isopod Shaeroma destructor (Richardson) Along the West Coast of Florida A. H. REHM University of Florida Research supported in part by - The Society of the Sigma XI

BIOLOGICAL SCIENCES SECTION

Friday, 2:00 pm, Session A, Room 326

Joseph L. Simon (University of South Florida) presiding

2:00
BS-26 Polychaete Fauna Associated with Gulf of Mexico Sponges. DANIEL M. DAUER, University of South Florida. Thirty-four species of polychaetous annelids were found associated with eight species of sponges from the Gulf of Mexico. All sponges were collected by scuba diving and placed individually in plastic bags. The contents were sieved with a 0.5 mm sieve to obtain the polychaetes associated with the sponge cortex. The sponges were dissected to find the polychaetes living within the body of the sponge.

The polychaete fauna is dominated in total numbers and in relative abundance by Syllis spongicola Grube. A few polychaetes (Branchiosyllis oculata Ehlers, Branchiosyllis sp., and Polydora colonia Moore) were found with high relative abundances and rare occurrences in different sponges. Approximately 80% of the polychaetes found associated with sponges occur in relatively low abundances and rarely in a large number of sponge species. The majority of polychaetes occur randomly with sponges. Their appearance is determined primarily by the external morphology of the sponge rather than by the species.

2:15

BS-27 Chaetognaths as Bioindicators in the Gulf of Mexico. ROBERT H. MATTLIN, JR., University of West Florida.--Chaetognaths have historically been shown to be useful bioindicators of certain watermasses. The present study investigates the usefullness of chaetognaths as bioindicators of watermasses in the Gulf of Mexico, with emphasis placed on the identification of the Loop Current and its meanders. Chaetognaths from plankton samples collected under the auspices of the State University System Florida Institute of Oceanography during EGMEX I-V cruises are being utilized. Specimens were collected using meter nets, neuston nets, and one-half meter opening-closing nets. The systematics and numbers of specimens are compared from each sampling location. Corresponding physico-chemical data are compared with biological information. From these comparisons, the relationship between species and abundance of chaetognaths and watermass characteristics are being established.

2:30

BS-28 A preliminary Survey of Marine Tardigrades of Florida. D.J. MCKIRDY, University of South Florida.--A survey was carried out from July, 1971 through January, 1972. Collections on both Florida coasts yielded representatives of all four known marine tardigrade families comprising five genera and eight species. Four are previously described species: *Batillipes mirus*, *Batillipes bullacaudatus*, *Batillipes pennaki*, and *Echiniscoides sigismundi*; while the remaining four are new or as yet unidentified species of *Batillipes*, *Stygarctus*, *Styraconyx*, and *Halechiniscus*. The latter three genera in addition to *Echiniscoides*, *B. bullacaudatus*, and *B. pennaki* are reported for the first time from Florida. Taxonomic characters used to distinguish species as well as relative abundances and distributions are discussed.

2:45

BS-29 Comparison of Quantitative Methods for the Estimation of Plankton Populations. SANDRA F. MILLER, University of West Florida.--Efficiencies of various quantitative methods for the estimation of plankton populations are being determined. The advantages and disadvantages of the most common methods propose the need for such a comparison. Data from membrane filtration techniques, settling or sedimentation techniques, and live counts for the estimation of organisms per unit volume, are being statistically analized to determine precision within methods, compared with methods incorporating biomass estimations. Accuracy, time involved, efficiency, and expense of the methods will allow recommendations to be made, which will help future investigators in choosing a method best suited to their needs.

3:00 COFFEE BREAK

3:15

BS-30 The Lethal Pathogen, Labyrinthomyxa marina, and other Causes of the Escambia Bay, Florida Oyster Mortality of September, 1971. J.A. QUICK, JR., National Marine Fisheries Service of NOAA*--An oyster kill (Crassostrea virginica Gmelin) was reported on the commercial reefs in Escambia Bay, Florida, on September 7, 1971, and an immediate investigation was launched by the Florida Department of Natural Resources Marine Research Laboratory. Mortalities had been rapid, extensive, and severe with 100% oyster loss in most areas and most deaths occurring in three days. The direct cause was an epizootic of the pathogenic fungus, Labyrinthomyxa marina (Mackin, Owen, and Collier) Mackin and Ray, but several other factors indirectly contributed to the kill, particularly the poor water quality of this industrially polluted bay system. Shell aging showed the commercial harvest to consist almost entirely of the second and third year classes indicating at least three years would be required for natural recovery. Extensive oyster relaying operations are underway to shorten this recovery period.

*Financed by the National Marine Fisheries Service of NOAA, through the Commercial Fisheries Research and Development Act, (Public Law 88-309).

3:30

BS-31 A Preliminary Survey of Mangrove Communities in Florida.* J.M. CARLTON, University of South Florida.--This paper will report on investigations being carried out on the plants associated with the mangrove vegetation of the Florida shoreline. Some preliminary work from selected sampling stations along both coasts will be noted with reference to species composition and ecological factors affecting these communities.

A preliminary study of Rhizophora mangle L. on Virginia Key, Biscayne Bay, will be reported on, having made use of aerial photographs for determinations of growth rates over a five year period.

*Research supported by National Science Foundation and Tropical Botany Seminar, University of Miami.

3:45

BS-32 A Quantitative Evaluation of Red-Tide Induced Mass Mortalities of Benthic Invertebrates in Tampa Bay, Florida.* JOSEPH L. SIMON, DANIEL M. DAUER, University of South Florida.--Mid-July to mid-August, 1971, a massive outbreak of the Red Tide organism (Gymnodinium breve) occurred along the west-central coast of Florida. Massive fish kills were reported especially heavy in Tampa Bay. Sampling and analysis of data immediately after the red-tide have shown that benthic intertidal invertebrates in parts of the bay were almost completely eliminated. Quantitative data before and after the outbreak showed that of the 22 commonest invertebrate species present prior to the red-tide, only 4 species were present after - and those in markedly reduced numbers. Among the species killed off were polychaetes, amphipods, crabs, bivalves, gastropods, phoronids, and amphioxus. A study is underway to follow repopulation.

*Supported by NSF Grant GA-31769

4:00

BS-32a Problems of aquatic weeds. Hydrilla verticillata - a case study. RAYMOND D. MARTYN, JR., DONALD S. MCCORQUODALE, JR. & THOMAS T. STURROCK, Florida Atlantic University.

4:15

BS-32b Laboratory cultivation of Hydrilla verticillata. DONALD S. MCCORQUODALE, JR., RAYMOND D. MARTYN, JR. & THOMAS T. STURROCK, Florida Atlantic University.

4:30

BS-33 Organism-Substrate Relationships in the Fiddler Crab Uca minax. NICHOLAS H. WHITING, University of West Florida.--Organism-substrate relationships in the fiddler crab, Uca minax were investigated over a two-year period. Sites studied involved locations on a thermally-augmented tributary, as well as thermally-natural sites on the Escambia River, Pensacola, Escambia County, Florida. Particular interest was directed toward the role of temperature, oxygen and organic content of the substrate, as these parameters affect the spatial and temporal distribution of this species.

4:45 BUSINESS MEETING - BIOLOGICAL SCIENCES SECTION, Room 326

BIOLOGICAL SCIENCES SECTION

Friday, 2:00 pm, Session B, Room 328

Glen E. Woolfenden (University of South Florida) presiding

2:00

BS-34 Metabolic Characteristics of the Golden Mouse, Ochrotomys nuttalli. P.G. DOLAN, Florida Technological University, J.N. LAYNE, Archbold Biological Station.--The conductance, basal metabolic rate (BMR), and thermoneutral zone (TNZ) and its limits were examined in the golden mouse, Ochrotomys nuttalli, by means of oxygen consumption, in order to determine whether a relationship existed between these physiological characteristics and the ecology and distribution of the species. Comparisons were made with various species and subspecies of Peromyscus.

Ochrotomys exhibited a lower BMR (1.20cc O_2-g^{-1}-hr^{-1}) and a narrower TNZ (3.0°C) than any Peromyscus of similar size. With the possible exception of conductance, the study offers little evidence of a correlation between metabolic rates and environmental conditions. The ecology and distribution of Ochrotomys does not appear strongly influenced by its metabolic make-up.

2:15

BS-35 Nest-building Behavior in Three Subspecies of *Peromyscus polionotus*. L.M. EHRHART, Florida Technological University.--Two measures of nest-building propensity were used to compare this behavior among populations of old-field mice (*Peromyscus polionotus*) from central Alabama; Santa Rosa Island, Florida; and Marion Co., Florida. Comparisons were also made between males and females and between field-captured and laboratory-raised subjects. The results suggest relationships between the strength of the nest-building response and environmental factors. Motor patterns involved in nest building are also discussed.

2:30

BS-36 Notes on a Trematode (Monogenea: Mazocraeidae) and its Host *Stromateus stellatus* (Stromateoidei). ARTHUR BUTT, University of West Florida.--Trematodes were collected from the butterfish *Stromateus stellatus*. Collections were made off the coast of Correll, Chile in 1967 and preserved in 70% alcohol. Trematodes were provisionally placed in the family Mazocraeidae (four pair of U-shaped clamps, two pair of unequal and dissimilar anchors, armed genital atrium, and two well developed prohaptors). Their opisthaptors and related structures were asymmetrical. Nineteen of the twenty-six trematodes observed had greater clamp development on the right side. Trematodes were rather large (3.5-6.0 mm in length) in comparison to the size of the gill filaments (7.5-10.5 mm in length). The host-parasite association may be considered an example of hyperparasitism (*sensu* Mansueti, 1963). The butterfishes are associated with scyphomedusae and siphonophorans which they seasonally feed upon voraciously.

2:45

BS-37 Notes on a Monogenetic Trematode and its Fish Host, *Siganus rivulatus*. CARROLL BERNIER, SNEED COLLARD, University of West Florida.--Fishes of the family Siganidae collected by gill net near acre (or Akko) in Israel and preserved in 10% formalin-seawater, were necropsied for metazoan symbiotes. Only monogenetic trematodes were recovered from *S. rivulatus* (a known Red Sea-to-Mediterranean Sea migrator). The depauperate symbiotic fauna observed may be an indication that heterogenetic helminths and crustacea have not been as successful as their fish hosts in successfully making the Suez Canal migration. A preliminary description of the trematode and the host-parasite relationship is presented.

3:00 COFFEE BREAK

3:15

BS-38 Notes on Epigean Populations of Fishes in Subterranean Waters of Florida. KENNETH RELYEA, BRUCE SUTTON, Jacksonville University.--No troglobitic fishes are known from Florida subterranean waters, but several species of epigean fishes are. These include: *Anguilla rostrata*, the American Eel; *Hybopsis harperi*, the creek chub; and *Ictalurus natalis*, the yellow bullhead. Subterranean populations of *Hybopsis* and *Ictalurus* from caves west of Gainesville, in Alachua County, are discussed. Populations of these fishes are apparently small and are found near sink-shafts which afford a "funnel-effect" for energy input. Analysis of stomach contents of the subterranean bullhead indicates some predation on troglobitic cray-

fishes, but the major food item appears to be springtails. Genetic and/or developmental abnormalities suggest that the bullheads are isolated from epigean populations.

3:30

BS-39 The Abundance and Size of Gulf Menhaden, Brevoortia patronus, Caught by Seine Haul in Mulatto Bayou, near Pensacola, Florida, from June, 1969 to June, 1971. MICHAEL D. SCHMITT, University of West Florida.--Mulatto Bayou is a semi-enclosed estuary, 214 acres in area, on the eastern side of Escambia Bay, approximately 16 nautical miles from the Gulf of Mexico. Three sites were seined twice monthly. Menhaden were counted and the length of individuals in a representative subsample were measured. Brevoortia patronus was present during all months except December, 1969 and January, 1970. Juveniles, 20-30 mm standard length (SL), were present from February to April in 1970 and 1971, and most abundant during the latter month. From May to November, a second, larger size class of individuals (60-100 mm SL) composed an increasingly larger part of the menhaden captured.

3:45

BS-40 Observations on the Behavior and Feeding Habits of the Atlantic Needlefish, Strongylura marina (Walbaum) and the Halfbeak, Hyporhamphus unifasciatus (Ranzani)--Suborder Exocoetoidei.* R.G. GILMORE, JR., University of West Florida.--Strongylura marina was found to inhabit a Northwest Florida estuary (Pensacola Bay and vicinity) throughout the year regardless of dramatic temperature and salinity change, while Hyporhamphus unifasciatus was found only during warmer months of the year (April-September) but in the Gulf of Mexico year around. The feeding habits of S. marina were found to be opportunistic reflecting the abundance of various food types during the year and the ecotope in which it was found. The halfbeak was also opportunistic and omnivorous in its diet.

*Section from Master's Thesis, University of West Florida, Pensacola.

4:00

BS-41 Current Research on the Biology of Bonefish, Albula vulpes, in Florida Waters. GERARD E. BRUGER, Florida Department of Natural Resources.--Aspects of the biology of the bonefish, Albula vulpes (Linnaeus), are under investigation using juvenile and adult specimens collected in south Florida waters. Significant differences are evident in growth rates of males and females, the males weighing more than females until approximately 400 mm SL. Bonefish may attain an age of over ten years. Confirmation of age estimates is awaiting examination of museum specimens in the 85-200 mm SL range.

Reports from investigators in south Florida and elsewhere indicate that juveniles less than 200 mm SL may be found over mud bottoms in mangrove areas. This aspect of juvenile ecology parallels that of the closely related elopomorphs, Megalops atlanticus and Elops saurus. Bonefish are carnivores, feeding primarily on bivalve mollusks, crustaceans, and to a lesser extent, fishes.

Detailed histological studies of gonadal maturation are underway. Specimens 200-300 mm SL collected at depths of 5.5-12.2 m between October and December were ripe or ripening. Larger specimens collected at the same time of year from shallow waters were not ripe. Since morphometric and meristic studies indicate conspecificity, this aspect of their life history is unexplained.

4:15
BS-42 Maintenance of Toxicity in Sphoeroides testudineus, the checkered puffer. EDWARD LARSON, MURRAY GIRARD, WARREN ZEILLER, Miami Seaquarium.--A group of Sphoeroides testudineus, the checkered puffer, was maintained under laboratory conditions. Assays for toxicity of various tissues by the mouse injection technique were made on certain number of these fish at the start of the experimental period and at intervals of 3, 6 and 9 months. Preliminary results show equal levels of toxicity. A group of Lutjanus griesus, gray snapper, treated in the same manner, served as a control.

4:30
BS-43 Limnological Festures of Lake Izabal, Guatemala. F.G. NORDLIE, University of Florida.--Lake Izabal is a large, relatively shallow lake forming the upper end of an estuarine system draining into the Gulf of Honduras. While the water is fresh, many of the organisms present - especially fishes - are of marine origin. An investigation of some basic limnological features of the lake was carried out during two visits - one in the late summer of 1969 and the second in the spring of 1970. The features studied included oxygen and temperature profiles, plankton, primary production, and bottom fauna. The most unexpected result of the investigation was the discovery of large numbers of Tanaidacea in the soft muds of the benthic regions.

4:45 BUSINESS MEETING - BIOLOGICAL SCIENCES SECTION, Room 326

PHYSICAL SCIENCES SECTION

Friday 9:00 am
P. L. Edwards, (University of West Florida) presiding

PS - 1 Carbonate Geochemistry, or Everything You always Wanted to Know About the Shell Game but Were Afraid to Ask WILLIAM H. TAFT and DEAN F. MARTIN University of South Florida

The results of field and laboratory studies of carbonate paradoxes will be summarized. What makes a theoretically unstable form of calcium carbonate persist in the marine environment? Why is the ocean supersaturated with respect to calcium carbonate? Why isn't more calcium carbonate being formed in the ocean? And, what are those metal ions doing in there, anyway?

9:30

PS - 2 The Making and Use of Random Dot Stereograms. MICHAEL T. HYSON, University of Miami. Random dot stereograms represent an interesting class of visual stimuli in which the information content may be precisely controlled through the use of a digital computer.

They are of great use in the study of visual processing by the brain and pattern recognition studies. The technique has, as well, many possible application in the field of mapping, flight simulation, and remote sensing.

The use of the Calcomp and Milgo plotters as a more universal technique will be discussed.

Various examples of stereograms will be presented by poloroid projection and hand held viewer. Stereograms yielding planes and tilted planes will be shown.

The relationship of this work to the single cell neurophysiology will be discussed.

For those interested, a way to make such stereograms by hand will be offered.

10:00 BUSINESS MEETING

10:30 COFFEE BREAK

10:45

PS - 3 Absorption Coefficient Spectroscopy in the Millimeter-Wave Region. WILLIAM C. OELFKE, Florida Technological University.--Some new techniques and spectrometer designs for the quantitative measurement of millimeter-wave absorption coefficients in gases are discussed. A comparison is made between the results of either phase locking a resonant absorption cavity to a modulated microwave source, or phase locking the microwave source to a frequency modulated absorption cavity. The results show that, the cavity modulated Fabry-Perot spectrometer is the most desirable system for the measurement of gaseous absorption spectra at pressures below 1 Torr as well as gaseous absorption coefficients at elevated pressures.

11:00

PS - 4

Structural Changes of Discontinuous Metal Films after Deposition, W.B. PHILLIPS, The University of West Florida, and D.N. BRASKI, Oak Ridge National Laboratory. -- Electron micrographs of discontinuous thin films of copper or gold, deposited at room temperature and observed *in situ* in an electron microscope at high vacuum, reveal pronounced changes in film structure when the film is heated above 500 K. These observed structural changes may be used to interpret the double reversal in sign of the temperature coefficient of electrical conductivity of similar films.

11:15

PS - 5 Propagation of Electromagnetic Pulses in a Collisional Magnetoplasma.* C. E. SEYLER, JR., R. W. FLYNN, AND S. C. BLOCH, University of South Florida.-- We describe computer solutions to the problem of the propagation of electromagnetic pulses in a magnetoplasma, for propagation parallel to the magnetic field. Our method is, we believe, a novel application of

the Fast Fourier Transform algorithm. The distortion of the pulse envelope is calculated for various values of ω_p/ω_0 , ω_b/ω_0 , ν/ω_0 , and propagation distance in the plasma.

Results are compared with earlier works on propagation in dispersive media.

* Research supported in part by the Atmospheric Science Section, National Science Foundation, Grant GA-10425.

PHYSICAL SCIENCES SECTION

Friday, 2:00 P.M.

S. C. Bloch (University of South Florida) presiding

PS - 11 The Remarkable Eclipses of ϵ Aurigae--Can a Black Hole be Seen? ROBERT E. WILSON University of South Florida It is shown that the mysterious eclipses of the primary component of the binary system ϵ Aurigae can only be due to a structure resembling the rings of Saturn--but with no visible object in the center of the ring system. It appears that the central mass must be a star which has collapsed to its gravitational radius, commonly known as a black hole.

2:30
PS - 12 The Importance of Research in Star Positions HEINRICH K. EICHORN von WURMB University of South Florida The accurate determination of star positions is ultimately necessary to calibrate distances in the universe and to describe our own galaxy. Celestial data are of practical use in geophysics. For the verification of the general theory of relativity star positions must be determined with extreme accuracy.

3:00
PS - 13 Florida as an Astronomical Site* ALEX G. SMITH and R. J. LEACOCK, Rosemary Hill Observatory, University of Florida In 1968 the new Rosemary Hill Astronomical Observatory went into operation near Bronson, Florida, with a 30-inch research telescope. Three years of continuous observations now make it possible to evaluate the site in terms of meteroological conditions, atmospheric transparency, and image stability.

*Supported by an NSF University Science Development Grant

3:15
PS - 14 4C05·34: The Most Distant Object in the Universe ?* RICHARD HACKNEY, KAREN HACKNEY, G. H. FOLSOM**, R. J. LEACOCK, R. L. SCOTT, and A. G. SMITH, University of Florida, Rosemary Hill Observatory. The quasar 4C05·34 has the largest red shift yet measured. If this effect is cosmological, the distance of 4C05·34 is enormous relative to the furthest known galaxies. Photographic efforts to detect light variations in the quasar will be reported.

*Supported by an NSF University Science Development Grant.
**Presently with the Department of Physics and Astronom y, Agnes Scott College, Decatur, Georgia.

3:30
PS - 15 A Search for Short-Term Optical Variations of BL Lacertae and 3C 120.* KAREN HACKNEY, A.G. SMITH, R.L. HACKNEY, R. J. LEACOCK, R.L. SCOTT, University of Florida, Rosemary Hill Observatory. A cooperative effort was made by several observatories to observe the peculiar object BL Lacertae and the Seyfert galaxy 3C 120 in the optical, infrared, and millimeter wavelength regions of their spectra simultaneously and continuously during five nights in November, 1971. Photographic observations with a time resolution on the order of 15 minutes obtained with the 30-inch reflector at Rosemary Hill are reported and discussed.

*Supported by an NSF University Science Development Grant.

3:45 COFFEE BREAK

4:00
PS- 16 Microstructure of One of Jupiter's Radio Sources.* R.J. LEACOCK and ALEX G. SMITH, University of Florida, Dept. of Physics and Astronomy Past University of Florida studies showed that Jupiter's "B" source of radio waves often appeared double as the planet rotated. A recent investigation shows a similar doubling as the satellite Io circles the planet. Implications for the theory of the radiation will be discussed.

*Supported by the National Science Foundation.

4:15

PS - 17 Structure of Circumstellar Envelopes About Be Stars. THOMAS H. MORGAN, KWAN-YU CHEN, Univ. of Fla. -- The structure and nature of the circumstellar material surrounding Be stars is studied by means of a simple hydrodynamical approach.

4:30
PS - 18 The Effect of Reflection on the Calculation of Radial Velocities of Close Spectroscopic Binary Stars.* W. J. RHEIN, Florida Tech. Univ. K-Y CHEN, University of Florida The radial velocities of many binary stars are calculated from the doppler shifts of observed spectral lines. It has been often assumed or stated in the literature that if reflection between close stars were taken into account, the results of the calculations would be different. The model of a real system of close stars, RZ Comae Berenices, was analyzed on a computer to investigate this effect. Results of the analysis indicate that the effect of reflection is not significant in the calculation of radial velocities for this system.

*Sponsored by NSF and NASA.

4:45

PS - 19 Photoelectric Observations of UZ Puppis. RAYMOND H. BLOOMER, JR., Rosemary Hill Observatory, Univ. of Fla. -- Three color photoelectric observations of the eclipsing variable UZ Puppis were obtained during the winter of 1971 using the photometer attached to the 30-inch telescope at the Rosemary Hill Observatory. The light curves and their solutions are discussed.

PHYSICAL SCIENCES SECTION

Saturday, 8:30 am

C. R. Burnett (Florida Atlantic University) presiding

PS - 21

Determination of the Asymmetry Parameter of the Electric Field Gradient of ^{35}Cl in Powder Samples. H. R. Brooker, W. W. Startup, Univ. of South Florida. The method of Morino and Toyama[1] for finding the asymmetry parameter of the quadrupole coupling constant of spin 3/2 nuclei has not been widely applied because of very stringent requirements on spectrometer sensitivity. We have largely overcome this difficulty by applying time averaging. Comparative results for para-dichlorobenzene and several other chlorine compounds will be presented.

[1] Y. Morino and M. Toyama, J. Chem. Phys. 35, 1289 (1961).

8:45

PS - 22 Use of the 13-Moment Approximation To Describe the Propagation of E-M Waves in the Ionosphere. R.N. RIGBY, The University of West Florida. The complex index of refraction for an Electro-Magnetic wave propagating in an ionized gas has been calculated by using the 13-moment approximation to obtain solutions to the Boltzmann Transport Equation. The approximations employ a cross-section similar to Nitrogen's. The results are compared to the more accurate (but less tractible) Chapman-Enskog approximation.

9:00 - PS 23

Ambipolar Diffusion Measurements in a Discharge Plasma.* J. T. Pytlinski, W. D. Jones, and N. L. Oleson, Univ. of South Florida. -- Using an ion-acoustic-wave technique[1] to measure plasma drift velocity and a Langmuir probe to measure the electron-density profile, we have determined the plasma diffusion "constant" as a function of radius for a steady-state argon discharge plasma. The significance of the calculated diffusion constant with respect to the ion mobility and ionization frequency will also be discussed.

*Research supported in part by USAEC Subcontract No. 3483.

[1] S. Aksornkitti, H.C. Hsuan, and K.E. Lonngren, J. Appl. Phys. 40, 2674 (1969).

9:15 - PS 24

Direct Energy Conversion in a Discharge Plasma. Dale D. Spurgin, W. D. Jones, N. L. Oleson, Univ. of South Florida, and I. Alexeff, Univ. of Tenn. -- By immersing one probe of a probe pair in a weak localized magnetic field, thereby greatly altering the electron mobility in the vicinity of the probe but not the ion mobility, we have been able to convert the random thermal energy of a simple discharge plasma directly into electrical energy. Preliminary studies indicate that the maximum power extracted is a function of several variables, including plasma density, magnetic field strength, and external "load" of the probe circuit.

9:30 - PS 25

Effect of Impurities on Excitations of a Solid.*E. RHODES and P. ERDÖS, Florida State University.--A simple Green function technique is described which may be used to find the excitations of a periodic lattice containing a substituted impurity, when the impurity-host interaction is of short range. The technique has been applied to lattice vibrations, electron bands, and spin wave bands. A recent application to the linear chain ferromagnet is discussed.

*Research sponsored by the Air Force Office of Scientific Research, Office of Aerospace Research, USAF, under AFOSR Grant No. AFOSR-70-1940.

9:45

PS - 26 Nonlinear Oscillations of a "Waterbag" Plasma.* D.J. STEENHOEK and R.W. FLYNN, University of South Florida. -- In the "Waterbag" model the electron distribution function is constant within a certain region of phase space and is zero elsewhere. With some restrictions this model is equivalent to a hydrodynamic description with an adiabatic equation of state, but more general behavior is also possible when "trapped" electrons and other multiple waterbag configurations are considered. The linear and nonlinear behavior of such plasmas will be discussed.

*Research supported by Atmospheric Science Section, National Science Foundation, and the Air Force Cambridge Research Laboratory.

10:00 - 11:00 PS - 27

ROSAE, The Global Earth Control Satellite Net W. H. GRISHAM, Florida Institute of Technology. ROSAE is a patented satellite net, which minimizes the physical constraints on multiple function satellite networks. This concept was developed for a broad spectrum of economic and socially beneficial satellite services. This paper will address aerospace technologies appropos to merging: observation, communications, navigation, and data control functions in a global net capable of managing the the world biosphere and man's socio-economic activities. Salient physical properties, geometry, kinematics, dynamics, orbital stability and major communication link parameters are enumerated; the constraints on the various functions are optimally integrated by this uniquely simple concept.

CONSERVATION SECTION

Friday 9 A.M.
John L. Taylor (National MarineFisheries Service) presiding

C-1 Drought and Drainage as they Affect the Southern Florida Water System and Ecology J.E. POPPLETON Florida Technological University

9:15
C-2 Brown Pelican Studies - A Progress Report MICHAEL J. FOGARTY, STEPHEN A. NESBITT, and LOVETT E. WILLIAMS, JR. Florida Game and Fresh Water Fish Commission, Gainesville, Florida

9:30
C-3 Captive Breeding and Pen-Rearing of Marine Turtles ROSS WITHAM, Florida Department of Natural Resources, Marine Research Laboratory, Jensen Beach, Florida.

9:45
C-4 Five-Year Creel Survey of Two Florida Lakes.*- F.J.Ware, W.V. Fish, and L. Prevatt; Florida Game and Fresh Water Fish Commission - - Sport fisheries of two Florida natural lakes, Griffin and Harris with surface acreages of 9,100 and 16,500 respectively, were surveyed from 1966 to 1971. The design employed was a stratified creel survey with non-uniform probability sampling. The survey provided for seasonal and annual estimates of fishing pressure, catch composition, and fishing success by species. Characteristics of the creel design are discussed. - - Annual fishing pressure for each lake varied from 175,944 man-hours to a high of 327,066 man-hours. Annual catches ranged from 125,994 fishes to 330,574 fishes. Principal components of the catch were largemouth bass, *Micropterus salmoides*, black crappie, *Pomoxis nigromaculatus*, bluegill, *Lepomis macrochirus*, and redear sunfish, *Lepomis microlophus*.

*This study was financed, in part, by Florida Federal Aid in Fish Restoration Project F-12.

10:00
C-5 Nutrients and Bacteria in Small Lake Conservation WILLIAM R. GARRETT and DAVID D. WOODBRIDGE University Center for Pollution Research, Florida Inst. of Technology. The problem of pollution in small man-made lakes is becoming increasingly more evident by the number of no swimming, boating or fishing signs posted around them. Conservation of these lakes is dependent upon a detailed knowledge of the time relationship of nutrients and the bacteria that accrue. Variations in concentration of nutrients and bacteria depend upon location and meteorological conditions. Relationship of nutrients, rainfall, and bacteria are presented for two lakes in Brevard County using the St. Johns River as a control.

10:15
C-6 Comparison of Carbon Fixation Rates in Two Estuarine Bayous JOHN K. ADAMS, University of West Florida. Comparisons of carbon fixation rates in Mulatto Bayou, a highly nutrified and disturbed system; and Catfish Basin, a relatively pristine estuary, both in Santa Rosa County, Florida, have been in progress since July, 1971 and will continue through June, 1972. Weekly collection of samples from surface, 0.5 meter, and 1.0 meter depths, and their *in situ* incubation, involves the application of the 14-carbon method employed against a weekly monitoring of physical-chemical data, including assays for phosphate, nitrate, and ammonia. Results to date suggest that Mulatto Bayou is a highly productive system with correspondingly erratic and fluctuating carbon fixation rates. In comparison, Catfish Basin shows substantially lower primary productivity and correspondingly stable and steady carbon fixation profiles. These results correlate with the high nutrient levels of Mulatto Bayou and comparatively low nutrient concentrations of Catfish Basin.

10:30 Business Session

10:45 Coffee

11:00
C-7 The Effects of Physical Alteration on Water Quality in Mulatto Bayou, Escambia Bay THOMAS S. HOPKINS University of West Florida Mulatto Bayou, located on the east side of Escambia Bay has undergone major physical changes as a result of the construction of Interstate 10 and subsequent real estate development. The most recent physical alterations (1970) involved maintenance dredging in response to local citizen's protests over loss of access to the bay. Beginning with the most recent alteration and for 12 months following, water quality and flushing was studied. In the dredged channel, dissolved oxygen values measured at 3 meters depth dropped to below 4.0 mg/L almost immediately. Continuing observations indicate that during summer months stratification develops, and dye studies confirm that excessive engineering has resulted in poor flushing.

11:15
C-8 A Preliminary Investigation of some Benthic Parameters Influencing the Distribution of Foraminifera. RICHARD D. SANFILIPPO, University of West Florida. A survey of three estuaries near Pensacola, Florida was conducted to determine the possibility of using foraminifera as biological indicators of water conditions. Sediments and the water immediately above them were analyzed for several environmental factors that affect the foraminiferal distribution patterns. Sediment composition and sedimentation rate as well as poor water quality are important factors that appear to be correlated with the diminishing numbers and diversity of foraminiferal populations. The reliability of several procedures of sampling foraminifera and of measuring water conditions in the estuary were compared.

11:30 C-9
Ecological and Hematological Studies on Clarius batrachus albina, J. W. Ward, University of South Florida College of Medicine, Tampa; H. C. Davis, Aquarium Supply Company, Tampa. This unwelcome, freshwater, edible, albino siluroid was introduced into Florida by tropical fish importers and released into streams by home aquarists when it became too agressive and too large for the home aquarium. This species possesses an auxillary respiratory apparatus in the branchial cavity which enables it to live in an aquatic environment with a low oxygen content and to make short excursions on land from one water source to another. It is omnivorous and has a voracious appetite. Differential blood counts were tabulated on peripheral blood by counting 500 leucocytes and 500 red cells. The following tabulation is recorded on a percentage basis: Erythrocytes, 97; 19 micra in diameter, nucleus 5 micra. Erythroblasts, 3; 21 micra in diameter, nucleus 7 micra. Lymphocytes, (small) 40%. Lymphocytes (large) 12%, 19 u. Neutrophil-like cells (ghost cells ?), 9%, 18 micra. Monocytes, 20 micra, 5%. Thrombocytes, 34%, 6 micra. The spleen and mesonephri are the principle hemopoetic organs, with isolated areas in the branchial tissue and the mesenteries. Further studies are in progress.

SOCIAL SCIENCE SECTION

Friday 9 A. M.
Ernest F. Dibble (University of West Florida, Dept. of History) presiding

"Symposium on Social Science Teaching"

SS - 1 The Uses of Visual Supplements in Social Science Teaching, Milton McPherson, Troy State, Alabama.

SS - 2 Maintenance of Reading Improvement for Dyslexic Children, Anita N. Griffiths, Educational Counselor, Lakeland.

Coffee Break

SS - 3 The New Middle School Curriculum, Jane Dysart, University of West Florida.

2:00 p.m. SOCIAL SCIENCE SECTION - - Ernest F. Dibble, Chairman

SS - 4 FHA - HUD Housing and Care Programs to Meet the Needs of the Elderly and Adapted to Florida, a Mecca for the Elderly, Mary Cathryne Park, Brevard Community College. Pioneering adaptations of federal programs to meet the needs of the elderly in Florida in a pattern that can be applied throughout the nation: (1) Condominiums for the elderly under FHA (2) Rental Units, with supplement, for low and middle income elderly (3) Section 23 supplement for rental living for elderly in rehabilitated structures (4) Intermediate Care Facilities (5) Extended Care Facilities (6) A proposal for group medical practice, with private, health insurance for the elderly at minimum cost.

SS - 5 A Social History of the Chilean Social Security System, John F. Speight, University of West Florida. This paper will outline the development of the Chilean social security system in particular and will attempt a sociological explanation of the role of social security as well as other forms of social welfare in the development of Latin America. The major perspective taken will be socio-historical and will focus on the Hispanic view of man and the social contract, ideological conflicts surrounding the demise of liberalism and individualism in the last decades of the nineteenth century and the first few decades of the present century, major organizational models employed in the establishment of social security programs in Chile, prevailing welfare ideologies, and how all these converge/diverge to affect the orgainzational functioning of three Chilean social security funds since their inception (1925-1930).

Coffee Break - Business Meeting, Social Science Section

SS - 6 Transportation - Need for Greater Intermodal Coordination, Albin N. Benson, formerly Federal Aviation Agency. This paper will give examples which illustrate the lack of intermodal coordaination in our transportation systems. It will also point out areas where progress is being made. Benefits derived from increased cooperation between the various travel modes will be discussed as they apply to the situation in Florida.

Format: Discussants and session speakers will conduct a short roundtable after papers are read.

Discussants: Norman Gilbert, Rollins College
Gilbert Lycan, Stetson University

SCIENCE TEACHING SECTION

Friday 9 am
L. B. Sanders (University of Florida) presiding

ST - 1 Computer Physics For Undergraduates. JAY S. BOLEMON, Florida Technological University. Special physics courses are being initiated at Florida Technological University to instruct our majors in developing computer solutions to physics problems. The problems selected are appropriate for both junior and senior students studying mechanics, electricity and magnetism, and modern physics. The instructor presents an initial method and program, and the class is required to improve the method and rewrite the program as their assignments. The students gain competence in FORTRAN as they progress. When working problems to which they know the answer, they must develop computer techniques to derive the solution to the desired level of accuracy. Results of experiences over one quarter will be presented.

9:15 - ST - 2

Implementation of Science Research Courses in Secondary School Curriculum, by Robert F. Richmond and David D. Woodbridge, Science Education Department, Florida Institute of Technology, Melbourne, Florida

Science Research courses have been instigated in the Brevard County School system as a result of support by the Cooperative College-School Science Program of the National Science Foundation. The program consisted of actual research projects carried out by the high school student under the direction of their research instructor. Florida Institute of Technology staff members worked in close relationship with the high school teachers on campus and in their own classrooms. F.I.T.'s direction and coordination assured that each research task developed in a meaningful manner.

9:30 ST - 3
A Simplified and Reliable Free-fall Apparatus for Laboratory Use B. J. JAIN, Florida A & M University Traditional laboratory experiments on free fall use indirect means for recording time and as a result, the inherent simplicity of the free fall motion is lost. By synchronizing the motion of the body with the time measuring device, a system for the automatic recording of the time has been developed which greatly simplifies the apparatus and gives better values of 'g'.

9:45 Business Session
10:00 Coffee Break

10:30 - ST - 4
Mastery Concepts in Individualized Earth Science, CHARLES J. MOTT, Department of Natural Sciences, Clearwater Campus, St. Petersburg Junior College

Auto-paced Earth Science using Mastery Techniques as taught at the Tarpon Springs Center of St. Petersburg Junior College is outlined. A brief discussion of the history of curriculum individualization via audio-tutorial techniques, and the mastery techniques employed in this experiment are presented.
Comparisons are advanced and conclusions made concerning the implementation of techniques of mastery learning.

10:45
ST - 5 Innovations In Space Science WILLIAM MELVIN TRANTHAM Florida Keys Community College. In order to familiarize students enrolled in Biology at Florida Keys Community College with short-term weightlessness, a single-engine Cessna 210 aircraft was chartered by the instructor. Keplerian trajectories were executed in the aircraft at an altitude of two thousand feet over the Gulf of Mexico, generating periods of weightlessness lasting from three to five seconds. By the end of five sequential trajectories most students were able to acclimate completely with all phases of the trajectory. Utilization of this technique generated a more than average amount of enthusiasm among the students and allowed them to experience firsthand a sensation usually reserved only for astronauts.

11:00
ST - 6 Students as Teachers ROBERT A. BERGIN and THOMAS G. PERTRAK Palm Beach Garden High School and Howell Watkins Junior High School
Field trips are desirable in many science classes, but are often difficult to arrange especially in junior high school. Students in senior high schools are able to leave school for a field experience more readily, but are not as motivated as junior high students. The authors teach marine biology to junior and senior high students in the adjoining schools. Volunteers from the senior high class led a field trip for junior high students, giving a "student-teacher" ratio of about four to one. Specific benefits and drawbacks of the plan are discussed.

11:15
ST - 7 The Emerging Role of the Science Supervisor: Behavior Modification. Jack D. Strickland, Alachua County & John J. Koran, Jr., Univ. of Florida. -- There is an increasing emphasis in science teacher education upon influencing teacher behaviors to correspond with desirable student outcomes in the contemporary curricula.[1] A review of research suggests that we can specify behaviors in science[2] and subsequently modify them.[3] This paper will be an attempt to describe the emerging role of the science supervisor as a behavior modification resource person in the public schools.

[1]Paul DeHart Hurd, New Curriculum Perspective for Jr. High School Science, (1970).
[2]John Smith, Journal of Research in Science Teaching, 8, (3), P. 231.
[3]J. J. Koran, Jr., "The Use of Modeling,Feedback and Practice Variables to Influence Science Teacher Behavior," Science Education in press, (1972).

SCIENCE TEACHING SECTION

Friday 2 pm
Harold Sims (St. Petersburg Junior College) presiding

ST - 8
WHAT IS ECOLOGY ? HAROLD W. SIMS, JR. ST. PETERSBURG JR. COLLEGE, CLEARWATER FLORIDA. A BRAND NEW FILM STRIP PRESENTATION EXPLAINING THE ORIGIN AND HISTORY OF THE SCIENCE OF ECOLOGY AND SHOWING THE WIDE FIELD IT COVERS. THE ACTUAL CASE HISTORY OF THE BUILDING OF THE CROSS FLORIDA BARGE CANAL, ILLUSTRATES A PRACTICAL APPLICATION OF THIS KNOWLEDGE AND HOW THE LACK OF IT LEADS TO DISASTER. THIS FILM STRIP IS BEING MARKETED NATIONWIDE BY WARREN SCHLOAT PRODUCTIONS, INC. PLEASANTVILLE, NEW YORK.

2:30

ST - 9 Environmental Education: Training Under Simulated Conditions. Donna R. Thompson, Alachua County and John J. Koran, Jr., Univ. of Florida. The state of Florida has adopted guidelines for the education of teachers and students in environmental education.[1] Behavioral outcomes can be classified both in cognitive and affective domains. A critical problem is arranging conditions under which students can have a wide range of experiences requiring decision making and also be confronted with making these decisions under simulated conditions. This paper will describe some behavior modification approaches which may be of significance to this problem.[2]

[1]Environmental Education, Florida Master Plan, Department of Education, (1971).
[2]John J. Koran, Jr., Two Paradigms for the Training of Science Teachers Using Videotape Technology and Simulated Conditions, Journal of Research in Science Teaching, 6, (1), (1969).

2:50

ST - 10 Science As the Disposition Toward Knowledge Operating Within an Interdisciplinary Environmental Education Program. RICHARD C. TILLIS, Florida Master Plan for Environmental Education. This paper will outline the basic philosophy and structure of the Florida Master Plan for Environmental Education and define the basic role of science education within the program.

3:05

ST - 11 Environmental Education, A Sensitivity Approach HAL SCOTT Florida Audubon Society, Maitland, Florida Methods of teaching environmental education through field experience in the natural environment. Learning by doing, not by being told.

3:20 COFFEE BREAK

3:40

ST - 12 Strategies For Implementing Environmental Education Programs.

W. F. HAMMOND, Lee County Environmental Education Program.-- This paper will identify proven strategies for implementing Environmental Education programs into local school systems through teacher training, community and student involvement.

3:55 ST - 13

"Entomology In Action" - A Career-Oriented Presentation for High School Students by The Florida Entomological Society.
By- W. B. Gresham Jr., President, Florida Entomological Society.

As one part of its Public Relations Program, The Florida Entomological Society has made up a presentation for use by its members consisting of 57 color 2X2 slides and a prepared script. This presentation is available on loan to any member when he has an opportunity to talk to junior or senior high school students to interest them in a career in one of the disciplines in the field of entomology.

4:15
ST - 14 Modern Biology--An Approach to the Teaching of Biology to Science Majors: Reflections after one Year.* C.S. HUANG Chipola Jr. College The teaching methods of Modern Biology currently undergoing experimentation at the college. Emphasis on the chemical aspects of life, the steady state systems, and environmental biology. The laboratory manual stresses molecular-analytical procedures of biological investigations. Students with strong backgrounds in science and mathematics have successfully completed their laboratory projects. Projects attracting students the most include: (1) Blood chemistry (the determination of hemoglobin and cholesterol, (2) Chemical analysis of urine (inorganic ions and organic compounds determination), (3) paper chromatography (separation of leaf pigment) and gas chromatographic techniques (4) Coliforms test, BOD test, chemical analysis of water studies (samples from local ponds and sewage plants, (5) Genetics (microorganisms isolated from nature are used for mutation studies and DNA isolation).

*Research supported by Chipola Staff and Program Development Plan 1971-72.

4:30 ST - 15
THE DIRECTIONS OF FLORIDA CONSERVATION ACTION, WILLIAM M. PARTINGTON, ENVIRONMENTAL INFORMATION CENTER, WINTER PARK, FLORIDA.

RANDON THOUGHTS ON WHAT DIRECTIONS FLORIDA CONSERVATION SEEMS TO BE TAKING, AND HOW THIS IS INVOLVING NEW TYPES OF ACTIONS AND THUS COMMUNICATIONS. WHEREAS WE FORMERLY WERE ENGAGED IN CONFRONTATIONS, WE NOW ARE TRYING TO UNDERSTAND EACHOTHER AND COOPERATE.

4:45 ST - 16 Pat Purcell

ADDICTION: DRUGS AND ALCOHOL

Public Symposium, Medical and Social Sciences Sections

Thursday, 8:00 pm
Welcome: James G. Potter, President-elect FAS
Opening Remarks
- Dr. Robert G. Sherrill, Jr., Medical Director of Hillsborough County Hospital Tampa; Chairman, Medical Sciences Section
- Dr. Ernest F. Dibble, University of West Florida, Faculty of History, Chairman, Social Sciences Section

Symposium Moderator: Judge D. Arthur Yergey, Former Juvenile Court Judge, Orlando, Florida
Panelists
- Dr. Walter E. Afield (Psychiatry) - Clinical Director of St. Joseph Hospital Mental Health Center, Tampa, Fla.; Professor and Chairman of the Department of Psychiatry, University of South Florida, Tampa.
- Dr. Harold D. Brewer (Family Practice) - Plant City Florida
- Dr. Sam A. Banks (Ministry) - Assistant Professor in Medicine and Religion, Department of Community Health, College of Medicine, University of Florida Gainesville, Florida.
- Dr. Kenneth S. Finger (Pharmacology) - Dean of College of Pharmacy, University of Florida, Gainesville, Florida
- Dr. Charles V. Unkovic (Sociology) - Professor & Chairman of Dept. of Sociology - Florida Technological University, Orlando, Florida

BIOLOGICAL EFFECTS OF ELECTRICAL POWER GENERATION

Public Symposium, Biological Science and Conservation Sections.
Saturday 8:15 am
John L. Taylor (National Marine Fisheries Service), presiding.
Opening Remarks - John L. Taylor

8:30
BS & C - 1 Environmental Research and Electric Power Generation KENNETH W. PREST, JR. Florida Power Corporation, Environmental Affairs Biologist. Scientific interest in the response of natural ecosystems to the stresses of industrial growth is certainly not new. However, direct industrial participation in the support of such research is becoming increasingly significant since the promulgation of the National Environmental Policy Act of 1969. In response to the intent of this policy, reflected in the subsequent requirements of such Federal Agencies as the U.S. Army Corps of Engineers and the Atomic Energy Commission, power companies are challenged to present a responsible perspective of environmental awareness which reflects a comprehensive understanding of the socio-economic and ecological implications of their proposed actions. An integral aspect in the development of this perspective is the function of environmental-ecological research. The coordination of research programs demands a realistic and systematic approach if the company is to make a responsible contribution to improving the quality of the environment and realize the benefits of its environmental investments.

During June 1970, the Florida Power Corporation established a Generation Environmental and regulatory Affairs Department within which the Environmental Affairs Section has the responsibility for developing the resources of environmental research. The functional effectiveness of the Section depends on the conjoint accomplishment of three interrelated objectives:

I. Develop and expeditiously execute environmental research programs upon which successful licensing, engineering, construction and operation of power plants may be based.

II. Utilize the knowledge gained through Company-sponsored and related environmental research toward the development of Environmental Reports and thus the reality of environmentally compatible electric power generation.

III. Responsibly relate the Company's environmental activities to the public, conservation groups, scientific community and governmental agencies in order to promote understanding of industrial-environmental interrelationships.

8:50
BS & C - 2 The Complexities of Thermal Effects Evaluations EDWIN A. JOYCE, Jr. Florida Department of Natural Resources, Biological Laboratory. The Marine Research Laboratory of the Florida Department of Natural Resources has been studying the effects of thermal effluents in the vicinity of the Crystal River Plant (Florida Power Corporation, Crystal River, Florida). The two main objectives were to obtain baseline ecological data prior to the opening of a nuclear generator which will double the present amount of effluent, and to evaluate the effects of the presently functioning fossil fueled units. Correlative studies were also conducted in Tampa Bay and in temperature controlled rooms at the main Laboratory facilities in St. Petersburg.

The Crystal River ecological evaluation showed little evidence of temperature induced damage or change. In fact, channel dredging appeared to have had the greatest deleterious effects. In addition, water temperatures taken on a shallow oyster bar in upper Tampa Bay were found to vary as much as 12^{o}C within 24 hours and the highest reading was 37^{o}C. Living oysters on a natural bar withstood temperatures of 49.5^{o}C when exposed to the sun at low tide. Such findings indicate the complexity of making thermal effects evaluations. Consequently, all factors must be considered and each case must be judged on the basis of its own particular set of characteristics.

9:10
BS & C - 3 The Making of a Power Plant, I: Environment and Design* T.E. PYLE, R.C. BAIRD, K.L. CARDER, T.L. HOPKINS, D.W. WALLACE, University of South Florida. In late 1970 the Marine Science Institute began a long-range study of the Acnlote River and Anchorage near Tarpon Springs prior to construction of a power plant at the river mouth. Within a few months university scientists made initial recommendations for changing design of the plant. Supporting statements from conservation groups and an economic analysis by industry led to the adoption in mid-1971 of the major recommendation that an overland pipeline be substituted for the dredging of a channel for oil barges. The critical problem now facing researchers, conservation groups and industry concerns the proposed degree of cooling and method of discharge of heated water. Although some significant design changes have been made as a result of environmental information, it should be emphasized that others have not and that ecologists had no input to the initial and probably more fundamentally important design stage, site selection.
*Research supported by Florida Power Corporation.

9:30
BS & C - 4 Title to be Announced ROGER STEWART Hillsborough County Pollution Control Commission

9:50 BS & C - 5
CONSIDERATIONS FOR LOCATING POWER PLANTS IN TROPICAL & SUBTROPICAL REGIONS.
By R.G. Bader, M.A. Roessler, G. L. Voss - University of Miami, School of Marine & Atmospheric Science.

The continual growth and movement of populations and the technological development of nations with accompanying industrial demands will require the construction of huge power plants in coastal areas. These plants must be favorably located and their heated effluent adequately disposed of in order not to cause ecological damage.

This paper discusses some considerations for power plant siting and gives some alternatives for development without severe damage to the environment.

10:10 BS & C - 6
LEGAL ASPECTS OF THERMAL POLLUTION. by D. O'Connor, Univ. of Miami, School of Law.

Examination of the problem of legal regulation of thermal pollution, including the jurisdiction of local, state and federal authorities. Appraisal of existing decision-making authority as applied to site selection, construction and operation of power plants, and a review of alternative basis for regulation for balancing development needs and environmental considerations.

10:30 BS&C-7
ON THE ECONOMICS OF THERMAL POLLUTION by Lee Anderson - Univ. of Miami, Department of Economics.

An economic model is presented that allows for the definition of the optimum amount of thermal pollution. That point is, of course, dependant upon the costs of pollution abatement and of pollution damage.

The remainder of the paper describes the procedure for applying this model to the real world. The discussion centers on the difficulties of the procedure and the information that will be necessary from natural scientists to complete it.

10:50 BS&C-8

EXCHANGE PROCESSES IN SHALLOW ESTUARIES by T.N. Lee and C. Rooth. Univ. of Miami, School of Marine and Atmospheric Science.

A modular approach to the analysis of mixing and flow characteristics in shallow tidal estuaries is presented using South Florida's Biscayne Bay estuary as an example. The method depends on isolating relatively simple characteristic flow regimes in different parts of an estuary. These can be considered as building blocks, which when recombined in different configurations are capable of yielding a qualitative model for any specific estuary. Such models are of immediate value in preliminary assessments of estuarine water quality and interaction problems. This method can serve as an effective base for further studies where more precise information is needed.

11:10 BS&C-9

Predicting Thermal Effluent Movement in the Anclote Anchorage* R. H. KLAUSEWITZ, Univ. of South Florida. -- This paper describes the study of the hydraulic movement in St. Joseph Sound/Anclote Anchorage prior to installation of a power plant there. Research includes synoptic current measurements, salinity distribution, nutrient distribution, particulate distribution and the positioning of recording current and depth meters. A hydraulic model developed by the staff has been employed to study the flow by computer. The model is being calibrated by field current measurements, range ratio measurements, phase lag, and overflight dye drops. This hydraulic model has capability to accomodate wind stress additions, mud flat run-on and run-off, and blockages in the path of water flow such as oyster bars or spoil banks. The output of the hydraulic model will be used in a dispersion model to predict areas which will be affected by the thermal effluent.

11:30 BS&C-10

Role of Historical Bathymetric Data in Resolution of an Ecological Problem* J.C. McCARTHY, T.E. PYLE, Univ. of South Florida.-- In 1970 it was proposed that a shoal south of Anclote Key near Tarpon Springs, Fla. be used as a spoil island in connection with the dredging of a channel for fuel barge deliveries to Florida Power Corp's. Anclote generating plant. As part of a study of this area, soundings made by the U.S.C.&G.S. in 1884, 1926, and 1953 were used to prepare bathymetric charts and, by means of overlays, to derive a net sedimentation/erosion map. Results indicated that the proposed site was not accreting or "becoming an island anyway" but that it had been in long-term dynamic equilibrium. This finding and negative biological comments eventually led to adoption of an alternative method of fuel delivery. The use of such reliable and widely available data from a Federal agency should be encouraged in all studies of effects of power plant construction.

* Research supported by Florida Power Corporation

11:45 BS&C-11

Reconnaissance Mapping of Turbidity in Estuaries* T.E. PYLE, J.C. McCARTHY, Univ. of South Florida, G.M. GRIFFIN, Univ. of Florida.-- Knowledge of the distribution of turbidity and suspended sediments in estuaries is important to a multitude of biological, geological, and technological studies and projects. Transmissometers measure the % transmittance of light over a 1m or 10cm path and can be towed at speeds up to 5 knots from a small boat to provide a synoptic picture of turbidity over a large area. At the same time water samples can be taken to determine total suspended load, the ratio organic/inorganic particles and other parameters. For more detailed studies the light source or photocell can be changed to compensate for water color effects and the instrument calibrated with formazin to give readings in JTU or FTU.

* Research supported by Florida Power Corporation.

BIOLOGICAL EFFECTS OF ELECTRICAL POWER GENERATION

Public Symposium, Biological Science and Conservation Sections.
Saturday 2:00 pm
Joseph L. Simon (University of South Florida), presiding.

2:00 BS&C-12

Problems of Quantitative Sampling in Relation to Near Shore and Estuarine Fishes K. ROLFES, W. CAUSEY, D. MILLIKAN, W. FABLE, AND R. BAIRD, Univ. of South Florida.-- Unlike many marine organisms fishes present a variety of difficulties in quantitative sampling due to their size and mobility. The problem is particularly critical in relation to site surveys where adequate quantitative sampling is essential for providing base-line data for evaluation of environmental impact. To date most surveys have had serious quantitative drawbacks and have often been inadequate for environmental evaluation. A sampling strategy employing a variety of methods is being developed for the Anclote Environmental Study* by the Department of Oceanography of the University of South Florida. The results to date, sampling bias, and the multi-gear approach to site surveys are discussed.

* Research supported by Florida Power Corporation.

2:15 BS&C-13

Aerial Mapping of Seagrass Beds* J. FEIGL, T.E. PYLE, R. CLINGAN, R. ZIMMERMAN, Univ. of South Florida. -- The extent of seagrass beds in estuaries and shallow coastal waters can be effectively and economically determined by using hand-held 35mm cameras in light aircraft. Beds of *Thalassia*, *Diplanthera* and *Syringodium* in Anclote Anchorage and St. Joseph Sound have been mapped by this method prior to construction of a power plant at the mouth of the Anclote River. Infra-red Ektachrome film has been used to record the distribution of tidal channels, borrow areas, sand flats and seagrass beds. This photography will provide the basis for determining seasonal fluctuations in the boundaries of these units and additional changes, if any, resulting from power plant construction and operation.

* Research supported by Florida Power Corporation.

2:30 BS&C-14

THE EFFECT OF HEATED EFFLUENTS ON A POPULATION OF THALASSIA TESTUDINUM IN BISCAYNE BAY. by A Thorhaug, R. Stearns and S. Pepper - Univ. of Miami, School Of Marine & Atmospheric Science.

The most important community in Biscayne Bay is that of the turtle grass, Thalassia testudinum. A two year study of the area near the point of heat effluence of a power plant was compared with the data from an uneffected area, Card Sound.

The results of these studies showed that in areas consistantly +5 and +4°C above the ambient that considerable damage to the Thalassia abundance and growth was evident. In the +1°C area the growth and abundance patterns resembled those in Card Sound except for flowering and fruiting of the plants.

2:50 BS&C-15

Recent Changes in Seagrass Dominants of Anclote Anchorage.* R. J. Zimmerman, Univ. of South Florida. Certain seagrass beds in Anclote Anchorage near Tarpon Springs, Florida have changed from a dominance of Thalàssia, reported in 1959,[1] to present dominance of Syringodium. The change is believed largely due to a general increase in turbidity of anchorage waters during that time. This view is supported by present seagrass zonation and present and past reports on water clarity.

*Research supported by Florida Power Corporation through the Univ. of South Florida at St. Petersburg.

[1] R. C. Phillips, Fla. Bd. Conser. Prof. Papers Ser. No. 2 72 pp. (1960).

3:05 BS&C-16

Photosynthesis Response to Temperature in Marine Phytoplankton with Reference to Adaptation. CHARLES S. YENTSCH University of Massachusetts Marine Station Observations on phytoplankton grown at different temperatures in the open oceans contribute a little to the scant knowledge on the effect of elevated temperatures on photosynthesis but are sometimes confusing because some algae adapt to different temperatures. Thus, the instantaneous response of photosynthesis to temperature, over a long time period, may not be indicative of how the algae are able to maintain their photosynthetic capacity in a given temperature regime. Whether or not the process of adaptation to different temperatures is specific or general to populations is not known; also unknown is the time necessary for a given population to adapt to the new temperature. However, recent evidence indicates that temperature acclimation in marine phytoplankton is accomplished by a shift in species. Individual species show little tendency to adapt.

3:25 BS&C-17

LABORATORY STUDIES OF TEMPERATURE TOLERANCES OF MAJOR BISCAYNE BAY ORGANISMS

by A. Thorhaug w/technical assistance of S.A. Bach and K. Kellar, Univ. of Miami, School of Marine & Atmospheric Science.

The physiology of tropical and subtropical estuarine organisms has enjoyed scant attention. Temperature, a fundamental factor for their survival and growth has been neglected. Laboratory studies were carried out on over 20,000 organisms of 35 species and life stages, and these results were integrated with simultaneous field investigations of these species. Lethal limit studies employing some 18,000 individuals showed that the expected Gaussian or skewed Gaussian curve did not materialize. Instead an abrupt death point occurred often with an interval of 1°C and in many cases within 0.5°C resembling a step function.

Results will be discussed.

3:45 BS&C-18

Preliminary Study of the Effects of Heated Waste Waters from a Steam Power Plant on Escambia River, in Northwest Florida. NICHOLAS DEGEORGES, University of West Florida. The area under study from April to June 1971 near Pensacola, consists of the cooling ditch, the lower end of Governors Bayou and the river from Governors Bayou outfall to the Escambia Bay (coordinates Lat. $30^{o}34'$N, Long. $87^{o}13'$W). Temperature, salinity and dissolved oxygen data were collected. Faunal determinations were made through plankton tows and growth platforms. Three distinct temperature zones were found to exist: the first was ambient river temperature; the second was in the cooling ditch, which was $3\text{-}6^{o}$ C above ambient. Faunal differences between the river and the cooling ditch were most distinct among the Copepod populations. The ditch had only Cyclopoid Copepods; while the River had Calanoid Copepods at the beginning of the study and as temperatures rose Cyclopoid Copepods began to appear and then predominate in the river.

4:00 BS&C-19

Effects of Heated Effluent on the Benthic Fauna of Tampa Bay. ROBERT W. VIRNSTEIN, University of South Florida. -- Benthic fauna near Tampa Electric Company's Big Bend Power Plant on southeast Tampa Bay was studied from February, 1970, through August, 1971, both before and after plant operation. The plant uses 240,000 gallons of bay water per minute heated 6-7 C. Preliminary analysis of data indicate elimination of some species and a decrease in density and diversity due to the temperature increase.

4:15 BS&C-20

OPTIMAL AND EXCLUSION TEMPERATURES FOR SUBTROPICAL ESTUARINE ORGANISMS by M. A. Roessler and D. C. Tabb - Univ. of Miami

A model based on the exclusion of species from the heated areas of Biscayne Bay is formulated to predict the impact of thermal additions on subtropical estuaries or coastal bays. This model was constructed from data based on the extent of damage with two 432,000 KWe fossil fuel units using 635 cfs cooling water apiece. Optimum temperature appeared to be near 26°C and 50% of the species were excluded at temperatures of 33°C or higher.

Predictions of the area to be affected with the addition of two 760,000 KWe nuclear units using 1490 cfs cooling water apiece and with the proposed semi-enclosed cooling canal system are made.

4:35 BS&C-21

Radionuclides in Liquid Wastes Released from a Nuclear Power Plant - Anticipated Doses to Marine Organisms and to Man. Bolch,W.E., C.E. Roessler, and W.E.S. Carr.

A study of both current and anticipated concentrations of radionuclides in the environment is in progress at the site of construction of a Florida Power Corp. nuclear power plant near Crystal River, Fla. Expected annual releases of radionuclides are known. The specific activity approach has been used to calculate future doses to marine animals and to man via seafood. Future dose levels are compared with the current doses received from radionuclides of natural origin and from fallout.

4:55 BS&C-22

Thermal Effluents and Mariculture VIOLET N. STEWART Big Bend Marine Laboratory, Tampa Electric Co. Observations on Stone Crabs, selected fishes, and oysters in the thermal effluent of a fossil-fueled power plant have confirmed the adaptability of certain organisms.

Growth rates, reproduction, and behavior have been recorded at elevated temperatures.

5:10 Concluding Remarks - J. L. Simon

CLEAN AIR TECHNOLOGY FOR SURGERY, SCIENCE AND INDUSTRY

Public Symposium, Medical and Physical Sciences Sections
Saturday April 8 1:30 P.M.

Moderator: Dr. Irwin S. Leinbach, Orthopaedic Surgeon, St. Petersburg, Florida.

Panelists: Bertha Yanis Litsky, Consulting Bacteriologist and Specialist in Environmental Control in Hospitals

Joseph Morris, M.D., Orthopaedic Surgeon, College of Medicine, University of Florida

Terry D. Stinson, Clean Air Specialist, Manager of Operations Support, Harris Semiconductor Division of Harris-Intertype Corporation.

Alan C. Harter, M.D., Specialist in Aerospace Medicine, Chief of Medical Services, Kennnedy Space Center

Kenneth P. Fallon, III, Operating Room Systems Division, Codman & Shurtleff, Inc.

Warren Litsky, Ph.D., Director of the Institute of Agricultural & Industrial Microbiology and of the Technical Guidance Center for Industrial Environmental Control, University of Massachusetts

Hector J. Defelix, Specialist in Super Clean Areas, Principal Production Engineer, Aerospace Division, Honeywell, Inc.

SPECIAL LECTURE

The Space Frontier, WILLIAM M. TRANTHAM, Florida Keys Community College. A 50 minute lecture-slide presentation to include the design and testing of a jet powered skate-board by college students, Gemini Rendezvous, Apollo 9, 11, 12, 15 and the Mariner 6 and 8 missions to the planet Mars.

(The above presentation has been prepared through the kind cooperation and assistance of Mr. Bill Nixon, Educational Service Director of the National Space and Aeronautics Administration; Mr. Gordon Wenger of the Jet Propulsion Laboratory in Pasendena for the computer updated slides of Mariner VI and VII missions; and Mr. Vernon MacPherson of Lockheed-California for the slides of the hypersonic SR-71. Parts of the Presentation were given at the 1970-71 National Science Teachers' Convention in Washington, and at St. Francis College in Biddeford, Maine last March.)

AMERICAN ASSOCIATION OF PHYSICS TEACHERS - FLORIDA SECTION

Friday 2:00 pm
Michael T. Kambour (Miami-Dade Junior College) presiding

PT-1 Single Concept Movie -- "Accelerated Motion", Joseph J. Boyle, Miami-Dade Junior College, South Campus, Miami, Florida.

A six minute, super 8mm film produced by three students at Miami-Dade Junior College, South Campus. Amusement park rides plus simple experiments are used to study circular motion.

2:15 - PT - 2

LET'S BRING MORE OF THE OUTSIDE WORLD INTO THE CLASSROOM. Stanley S. Ballard, University of Florida. These are times when we are trying to establish the relevance of physics to real life and are trying to reach non-scientists, to impart to them some feeling of the nature of physics and allied hard sciences. In order to reach the liberal arts students we must stay away from the jargon of science and use a minimum of the mathematical treatment which seems so elegant to us but may be frightening to them. We should select more attractive examples of the operation of physical laws, taking them from actual life situations rather than engineering applications. Our quizzes and examinations should try to bring out independent thought rather than being pure recall or mathematical exercises. All this represents a considerable challenge to our conventional methods of teaching physics, but it is a challenge that we must accept.

2:30 Business Meeting

2:45 SYMPOSIUM: Personalized Systems of Instruction

Moderator: Irving G. Foster
Florida Presbyterian College

PT-3 A Comparison of the Conventional Physics Lecture Course to a Self-Paced Self-Study Competency-Based Approach with Contract. JOSEPH L. AUBEL, University of South Florida

PT-4 A Course in 20th Century Physics Using an Individualized Method. ROBERT J. GOLL, Miami-Dade Junior College, North Campus.

PT-5 Laboratory Approaches in a Keller Plan Physics Course. JOHN S. ROSS, Rollins College

PT-6 "Mini Courses" for Freshman Chemistry. MICHAEL T. KAMBOUR, Miami-Dade Junior College, South Campus.

PT-7 Use of Individualized Instruction in a Course for Science Teachers. CARL A. BABSKI, Miami-Dade Junior College, North Campus.

DISCUSSION PERIOD.

OPTICAL SOCIETY OF AMERICA - FLORIDA SECTION

Joseph G. Hirschberg (University of Miami) President, Presiding

Saturday, April 8, 1972
9:00 am Contributed Papers
10:30 Business Meeting
11:00 Joint Session with American Association of Physics Teachers and Science Teaching Section
Pocket Fourier Spectroscopy - Bruce H. Billings, Immediate Past President, The Optical Society of America
2:00 pm Contributed Papers

FLORIDA STATE SCIENCE TALENT SEARCH

This is open to students, grades 10 - 12, in all public and private schools. Winners from the ten State Regions and the Junior Academy will present papers on their investigations including some experimental work. A $500 college science scholarship is granted by the William G. and Marie Selby Foundation to the winner. Also two all-expenses-paid three-week participantships in the National Youth Science Camp in West Virginia are awarded to two senior boys through invitation of the Governor of Florida. In addition, Certificates of Excellence and of Merit are awarded. All interested are invited to attend the presentation of papers.

FLORIDA JUNIOR ACADEMY OF SCIENCE
Thirty Third Annual Meeting
Friday, April 7, 1972

8:00 Registration - Bush Science Center Foyer

9:00 PRESENTATION OF JUNIOR HIGH RESEARCH PAPERS
Chemistry Lecture Room - 108
Presiding - Joey Nolan

Thymine Dimer Photoreactivation Properties of Far-Ultraviolet Irradiated Cells of *Escherichia coli*.
Donna Self - Roosevelt Junior High School

The Theorectical Reactivity of Carbon Suboxide in the Martian Atmosphere
Carl Ficarrotta - Cocoa High School

"The Mad Hatter Appears Again" - Mercury Pollution: A World-Wide Problem
John Denninghoff - Edgewood Junior High School

Thermal Effect on Plankton
Alicia Sinclair - Nautilus Junior High School

Microwave Amplification and Pumping of Hydroxyl Molecules
George Ellis - Largo Junior High (Science Center)

Transplantation, Permeability, and Active Transport of the Small Intestine of the Mesocricitus Auratus Auratus
Betty Ann Adams - Kennedy Junior High School

A Chemical Analysis of Sykes Creek
Margaret Ann West - Kennedy Junior High School

The Effects of Circulating Antibody as Related to the Immunologic Enhancement of the SV40 Tumor in the Mesocricetus Auratus Auratus
Denise Anne Miller - Rockledge High School

9:00 PRESENTATION OF SENIOR HIGH LITERARY RESEARCH PAPERS
Bush Auditorium - 127
Presiding - Mike Pace

Quasars
Murlene Wiggs - J. M. Tate High School

Enzymatic Repair of Ultraviolet Induced Pyrimidine Dimerization in DNA
Tim Jones - Cocoa High School

Phytochrome and Photomorphogenesis
Lola Brabham - Gainesville High School

Benzoic Acid - 3 Hydroxyacetate: Synthesis and Contrast/Comparison to Lesions Incurred by Acetylsalicylic Acid
George Zima - Cocoa Beach High School

The Relationship Between the Structure of Polyribosomes and the Time of Their Appearance in Sea Urchin Eggs
Shonnie Gramly - Cocoa High School

Flowering and Fruiting and Its Relationship to Senescence in Plants
Barbara Frierson - Cocoa High School

A Study of the Evolution of Cellular Biochemistry in Relation to Enzymatic Activity
Brian Stenquist - Naples High School

Culturing Methods of the Opalinids
Dave Seibert - Cocoa High School

11:00 SPONSORS' MEETING

Students invited to attend:

Senior Academy Sessions - Bush Science Center

Science Talent Search - Bush Science Center

12:00 LUNCH

1:00 GENERAL SESSION
Bush Auditorium - 127
Presiding - Ruth Babyak

Welcome - President, Rollins College

1:15 PRESENTATION OF HIGH SCHOOL EXPERIMENTAL RESEARCH PAPERS

A Comparative Investigation of the Relative Medullary Thickness and Urine Concentrating Abilities of Desert Rodents
Mike Pace - Merritt Island High School

Prevention of Endotoxin Shock by Antihistamines in Mice
Teresa Rittmanic - Merritt Island High School

The Pathological and Clinical Significance of Magnesium Depletion Appearing in Cardiovascular Disease
Benjamin Max Mondschein - Miami Beach Sr. High School

The Prefection of a Method for the Determiniation of the Critical Surface Tension of Powdered Polymers
John R. Minter - Terry Parker High School

A Study of the Effects of Colchicine and Trimethylcolchicinic Acid Methyl Ether D-Tartrate on the Metabolism and Mitotic Index of Malignant Neoplastic Tissue
Joseph G. Nolan - Merritt Island High School

Mid-Brain Reticular and Caudate Nucleus Formation Influences on Sub-Level Kindling of Anygdaloid Focal Epilepsy
Mark Rittmanic - Merritt Island High School

Auxin Chemistry: Mechanisms of 2, 4-D Herbicidal Action
J. Michael Verlander, Jr., Melbourne Central Catholic H. S.

"Water, Water Everywhere, Nor Any Drop to Drink"
Corey J. Mullins - Merritt Island High School

3:15 BUSINESS MEETING
Presiding - Mike Pace

6:00 AWARDS BANQUET- Rose Skillman Dining Hall

OFFICERS OF JUNIOR ACADEMY

PRESIDENT:	MERRITT ISLAND HIGH SCHOOL
VICE PRESIDENT:	EDGEWOOD JUNIOR HIGH SCHOOL
SECRETARY-TREASURER:	COCOA HIGH SCHOOL
STATE DIRECTOR:	JUNIOR ACADEMY OF SCIENCE LLOYD D. GRIFFITH COCOA HIGH SCHOOL
STATE DIRECTOR:	FLORIDA ACADEMY OF SCIENCE DR. FRANK DUDLEY UNIVERSITY OF SOUTH FLORIDA
EXECUTIVE COMMITTEE:	MRS. PATRICIA DENNINGHOFF MR. LARRY BECHTEL MR. KEN MARX MR. CRAIG BROSIUS MR. DAVID MOSRIE
ROLLINS COLLEGE LIAISON AND SCIENCE FAIR COORDINATOR	DR. ROBERT E. ROTH

EXHIBITORS

The following industrial firms will be exhibiting their products at this annual meeting. The Academy wishes to express its sincere appreciation for their support. Unfortunately the list is incomplete because of the early date of printing.

Fisher Scientific Company . . . . . . Laboratory Supplies

McGraw-Hill Book Company . . . . .Textbooks

Hewlett-Packard Company . . . . .Electronics

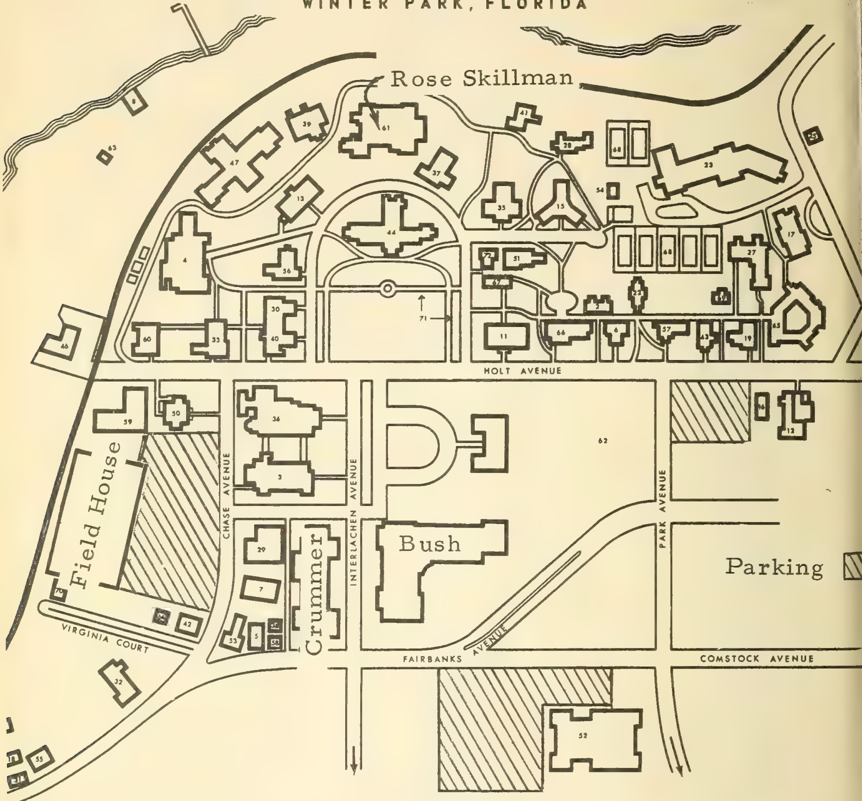
Lanier--A Division of 3-M. . . . . Audio Visual

Wards . . . . .Biological Supplies

Seymour-Lenz . . . . .Scientific Equipment

ROLLINS COLLEGE

WINTER PARK, FLORIDA



DR. PIERCE BRODKORB, Editor
Department of Zoology, University of Florida
Gainesville, Florida 32601

ADDRESS CORRECTION REQUESTED

NON PROFIT ORG.
U.S. POSTAGE
PAID
GAINESVILLE, FLORIDA
PERMIT 395

Quarterly Journal
of the
Florida Academy of Sciences

Vol. 35 June-September, 1972 No. 2-3

CONTENTS

First occurrence of the violet goby in Georgia
Paul L. Wolf, Sheryl F. Shanholtzer, and R. J. Reimold 81

Vegetational changes in the National Key Deer Refuge-II
Taylor R. Alexander and John D. Dickson III 85

Composition of *Thalassia testudinum* and *Ruppia maritima*
Gerald E. Walsh and Thomas E. Grow 97

Noteworthy marine fishes from eastern Louisiana *Jerry G. Walls* 109

Antarctica, isostacy, and the origin of frogs
Coleman J. Goin and Olive B. Goin 113

Characteristics of the western Atlantic reef-fish fauna
Carter R. Gilbert 130

Annotated checklist of the Boynton Beach hammock
Daniel F. Austin and Joanne G. Weise 145

A sediment trap for use in soft-bottomed lakes
Frank G. Nordlie and John F. Anderson 155

New records for fishes in South Carolina waters
David M. Cupka and Robert K. Dias 158

Published November 5, 1973

QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

Editor: Pierce Brodkorb

The Quarterly Journal welcomes original articles containing significant new knowledge, or new interpretation of knowledge, in any field of Science. Articles must not duplicate in any substantial way material that is published elsewhere.

INSTRUCTIONS TO AUTHORS

Rapid, efficient, and economical transmission of knowledge by means of the printed word requires full cooperation between author and editor. Revise copy before submission to insure logical order, conciseness, and clarity.

MANUSCRIPTS should be typed double-space *throughout*, on one side of numbered sheets of 8½ by 11 inch, smooth, bond paper.

A CARBON COPY will facilitate review by referees.

MARGINS should be 1½ inches all around.

TITLES must not exceed 55 characters, including spaces.

FOOTNOTES should be avoided. Give ACKNOWLEDGMENTS in the text and Address in paragraph form following Literature Cited.

LITERATURE CITED follows the text. *Double-space* and follow the form in the current volume. *For articles* give title, journal, volume, and inclusive pages. *For books* give title, publisher, place, and total pages.

TABLES are charged to authors at $25.00 per page or fraction. Titles must be short, but explanatory matter may be given in footnotes. Type each table on a separate sheet, *double-space, unruled,* to fit normal width of page, and place after Literature Cited.

LEGENDS for illustrations should be grouped on a sheet, *double-spaced,* in the form used in the current volume, and placed after Tables. Titles must be short but may be followed by explanatory matter.

ILLUSTRATIONS are charged to authors ($17.00 per page or fraction). DRAWINGS should be in India ink, on good board or drafting paper, and lettered by lettering guide or equivalent. Plan linework and lettering for reduction, so that final width is 4⅛ inches, and final length does not exceed 6⅝ inches. Do not submit illustrations needing reduction by more than one-half. PHOTOGRAPHS should be of good contrast, on glossy paper. Do not write heavily on the backs of photographs.

PROOF must be returned promptly. Leave a forwarding address in case of extended absence.

REPRINTS may be ordered when the author returns corrected proof.

Published by the Florida Academy of Sciences

Printed by the Storter Printing Company
Gainesville, Florida

QUARTERLY JOURNAL
of the
FLORIDA ACADEMY OF SCIENCES

Vol. 35 June-September, 1972 No. 2-3

First Occurrence of the Violet Goby in Georgia

Paul L. Wolf, Sheryl F. Shanholtzer, and R. J. Reimold

During a routine weekly survey of the aquatic fauna and flora of an undisturbed salt marsh ecosystem, one living specimen of the violet goby, *Gobioides broussonneti* Lacépède, was collected. Previous collections of this species are reported by Gunter and Hall (1963), Kritzler (1950), Miller (1966), and Tagatz (1968).

The violet goby has been collected from the following places in the United States: St. Johns River, Florida; inland waterwater near Salerno, Florida; St. Lucie Estuary, Florida; New Orleans; and Freeport, Texas. Gunter and Hall (1963) report collecting *G. broussonneti* from salinities of 0.22-0.24 parts per thousand (the salinities being determined by chloride titrations and by a hydrometer). Miller (1966) reported these fish to be included among the fresh water fishes of Central America, however no salinity ranges were reported. Kritzler (1950) examined a specimen after it had been caught in the intake screens to a power plant and then preserved and kept at the Jacksonville Florida Children's Museum for identification. Fowler (1947) reports identifying a violet goby captured and preserved nearly a month earlier. In both instances cited above the authors did not see the living fish and consequently only speculated as to its appearance prior to fading in the preservative. Tagatz (1968) collected seven *G. broussonneti* from the St. Johns River, Florida, in salinities ranging from 0.0-23.7 parts per thousand and a temperature range of 16.8-34.4C.

The violet goby reported herein was captured 2 July 1969 in the Duplin River Estuary, Sapelo Island, Georgia. The fish was captured in a 10 foot otter trawl, 3/4″ mesh, using a two speed of 2.0 knots. The trawl was made against the tide; the tide was within

one-half hour of high slack water. The water temperature in which the violet goby was captured was 29.5C, while the salinity of the water was 23.0 parts per thousand.

All proportional measurements were made in terms of standard length unless otherwise noted. Measurements of the fish are listed in Table 1. Table 2 provides a comparison of the measurements of the fish captured with those reported elsewhere in the literature. These determinations were all taken on the freshly captured specimen prior to preservation in 10 per cent hexamine buffered sea water formalin. General body shape and coloration closely resemble specimens described by Jordan and Everman (1902).

The specimen described above represents the first reported occurrence of the violet goby north of Florida. This is the second time also that the fish has been collected in higher salinity waters. Further observations on the osmoregulatory ability of this fish are needed to determine whether it should be described as a fresh

TABLE 1

Measurements of *Gobioides broussonneti* from Duplin River Estuary, Sapelo Island, Georgia

Total length	400 mm
Standard length	315 mm
Body depth	12.6 in. Standard Length (S.L.)
Depth of caudal peduncle	21.0 in. S.L.
Predorsal length	4.6 in. S.L.
Length of dorsal	1.3 in. S.L.
Length of anal	1.7 in. S.L.
Height of dorsal	24.0 in. S.L.
Head length	6.1 in. S.L., 2.5 snout to vent
Length of caudal	3.8 in. S.L.
Depth of head	12.6 in. S.L.
Width of head	10.5 in. S.L.
Snout length	5.8 in. head
Postorbital length	9.0 in. S.L.; 1.5 in. head
Length of eye	13.0 in. head
Length of longest pectoral	11.6 in. S.L.
Length of longest pelvic	11.6 in. S.L.
Length of upper jaw	15.0 in. S.L.; 2.5 in. head
Length of mandible	16.5 in. S.L.; 2.7 in. head
Vent to caudal peduncle	1.8 in. S.L.
Vent to snout	2.3 in. S.L.
Interorbital space	1.25 diameter of eye

TABLE 2

Comparison of measurements of *Gobioides broussonneti* from Duplin River Estuary and *G. broussonneti* from Jordan and Everman (1902) and Kritzler (1950)

Measurement	Duplin River	Jordan & Everman	Kritzler
Depth in standard length	12.6	13	11
Head length in standard length	6.1	5.25-7.0	6.8
Head length in snout to vent	2.5		2.6
Head width in head length	1.4		1.3
Length of eye in head length	13.0	7-10	12.6
Least depth of caudal peduncle in head length	2.8		2.9
Length of largest pectoral in head length	1.9		1.6
Length of largest pelvic in head length	1.9		1.4
Interorbital space (in eye diameter)	1.25	1-1 1/3	
Snout length in head	5.8		4.75
Interorbital in snout	1.8		1.4
Least depth of caudal peduncle in head	3.5		2.9

water fish which strayed into the estuary or whether it is a truly euryhaline species.

LITERATURE CITED

FOWLER, H. W. 1947. The Barrets—*Gobioides broussonnetii* Lacépède—obtained in Florida by Captain William B. Gray. Notulae Nature, vol. 197, pp. 1-4.

GUNTER, G., AND G. E. HALL. 1963. Additions to the list of euryhaline fishes of North America. Copeia, 1963, no. 3, pp. 596-597.

JORDAN, D. S., AND B. W. EVERMAN. 1902. American Food and Game Fishes. Doubleday, Page and Co. New York.

KRITZLER, H. 1950. Broussonets' Goby from the brackish water of lower St. Johns River, Florida. Copeia, 1950, no. 1, pp. 64-65.

MILLER, R. R. 1966. Geographical distribution of Central American Fresh-water Fishes. Copeia, 1966, no. 4, pp. 773-802.

TAGATZ, M. E. 1968. Fishes of the St. Johns River, Florida. Quart. Jour. Florida Acad. Sci., vol. 30, no. 1, pp. 25-50.

Marine Institute, University of Georgia, Sapelo Island, Georgia 31327 (present address of senior author: *Department of Biology Lebanon Valley College, Annville, Pennsylvania).* Contribution No. 229, Marine Institute, University of Georgia, Sapelo Island, Georgia.

Quart. Jour. Florida Acad. Sci. 35(2) 1972(1973)

Vegetational Changes in the National Key Deer Refuge-II

Taylor R. Alexander and John D. Dickson III

This report is the second one of a continuing study started in 1968 to determine vegetational changes in the National Key Deer Refuge since the initial study in 1951 (Dickson, 1955). The first report (Alexander and Dickson, 1970) documented the changes in the northern part of Big Pine Key. The northern part was mostly a prairie in 1951 and currently supports an entirely different vegetation type from the pineland that covers most of the Key. The pineland is the subject of this study.

Most of the pineland occurs on four Keys: Big Pine, Little Pine, No Name, and Cudjoe. Of these, No Name is outside the Refuge and is being developed for housing. The pineland of Big and Little Pine Keys is of great importance for deer range. Little Pine Key is about 600 acres in size and of this about nineteen per cent is pineland. Big Pine Key is about 6,000 acres and about thirty-eight per cent pineland. Since a large portion of this pineland on Big Pine Key lies south of the Refuge, the amount of protected pineland within the Refuge is very limited. The study reported herein was confined to the pineland of Big Pine Key. A complete description of the Refuge can be found in the U.S. Fish and Wildlife Service pamphlet, R1-518 (1965).

The two objectives of the current study were to document the changes in the pineland since 1951 and to provide information that might be useful in decision making for vegetational management. The latter relates mostly to the question of the use of fire on the Keys to control plant succession in the pineland.

Data for the original study was collected during 1951-52 and for the current study 1969-70. These two will be referred to hereafter as 1951 and 1969 data and the comparisons will be considered to cover the changes over an eighteen year period. All the sites used for quadrats had been fire-free during the period.

Methods

Twenty quadrats, 3×100 feet were studied to analyze changes in the tree and shrub population. Thirty quadrats, 3×3 feet were

examined for herbaceous vegetation. The smaller quadrats were located within the larger. An attempt was made to randomly sample the area and follow procedures previously reported (Dickson, 1955), so that the 1969 data could be compared directly with those of 1951. Plant names, numbers, heights and per cent of cover were determined. The last was recorded as four classes: 1 (less than 1 per cent); 2 (1-5 per cent); 3 (6-25 per cent), and 4 (26-50 per cent). Frequency figures are the percentage of quadrats in which a species occurred. Density values are the average number of individuals per quadrat. Counts for trees and shrubs were converted to plants per acre. Plants browsed by deer were noted, based on information determined in 1951 from stomach and pellet analyses, and direct observations. Plant names used are from the checklist of Lakela and Craighead (1965).

Results and Discussion

Comparison of Tables 1 and 2 shows that 20 woody species were listed in 1951 and 25 in 1969. Of the 25, nine were new to the list and four species of the 1951 study were not found in 1969. The new species are in the last half of the 1969 list and represent species that are found in mature pinelands, usually as invasion species leading toward a climax forest. The one exception is important. It is the exotic *Schinus terebinthifolius*, locally called Florida holly or Brazilian pepper. As is the case with many exotics, this one is spreading rapidly throughout the warmer areas of Florida. It is bird-spread and will form dense stands at the expense of native vegetation. It should be eliminated when found in the Refuge. One of the four 1951 species not found in 1969 is *Reynosia septentrionalis*. It is very common on the northern end of the Key (Alexander and Dickson, 1970). In 1951 it was listed but with low frequency. It was not seen in any quadrat, nor contiguous pineland areas in 1969. The other three, not counted in 1969, *Suriana, Rhacoma* and *Jacquinnia*, were seen occasionally but did not occur in the quadrats. *Cassia bahamensis*, occurring in 1969, did not appear in the 1951 quadrats.

Pines have doubled in number during the 18 years. Several size classes are present. However, there is a significant reduction in the

TABLE 1
Density per Acre of Trees and Shrubs by Four Size Classes, 1951

Species	Under 1′	1′–4′	4′–12′	12′–55′	Total	Freq.	Cover	Deer Food
Coccothrinax argentea	1844	726	58		2628	100	3	*
Randia aculeata	1162	188			1350	50	1	*
Eugenia longipes	595	566			1161	90	3	
Pithecollobium guadelupense	247	639	116		1002	40	1	*
Pisonia rotundata	218	450			668	90	2	
Pinus elliottii var. *densa*	43		102	378	523	90	4	*
Metopium toxiferum	479	29			508	20	1	
Serenoa repens	87	392			479	60	3	
Reynosia septentrionalis	44	261			305	10	2	
Byrsonima cuneata	58	159	15		232	80	2	
Thrinax microcarpa	29	145	44		218	70	2	*
Conocarpus erecta	44	29	29		102	30	2	*
Erithalis fruticosa	15	87			102	10	1	*
Rapanea guianensis	44	43			87	30	1	
Acacia peninsularis		29			29	10	1	*
Sophora tomentosa	15				15	20	1	
Jacquinnia keyensis		15			15	10	1	*
Rhacoma crossopetalum			15		15	10	1	
Suriana maritima	15				15	10	1	
Torrubia longifolia			15		15	10	1	*
Totals	4939	3758	394	378	9469			

TABLE 2

Density per Acre of Trees and Shrubs by Four Size Classes, 1969

Species	Under 1′	1′–4′	4′–12′	12′–55′	Total	Freq.	Cover	Deer Food
Coccothrinax argentea	378	1016	203	7	1604	100	3	*
Pithecollobium guadelupense	276	552	232		1060	50	2	*
Pinus elliottii var. *densa*	319	247	189	290	1045	95	3	*
Eugenia longipes	276	661	14		951	85	3	
Thrinax microcarpa	203	290	196	15	704	90	3	*
Pisonia rotundata	167	319	15		501	95	1	
Byrsonima cuneata	51	225	7		283	50	2	
Randia aculeata	189	87			276	25	1	*
Metopium toxiferum	87	102	29	7	225	45	2	
Cassia bahamensis	102	43			145	25	1	
Conocarpus erecta	58				58	5	1	*
Serrenoa repens		51			51	25	1	
Erithalis fruticosa	29	15			44	10	1	*
Schinus terebinthiofolius	29				29	5	1	
Myrica cerifera		7	15		22	10	1	
Piscidia piscipula	22				22	5	1	
Sophora tomentosa		15			15	10	1	
Torrubia longifolia		7	7		14	5	1	*
Coccoloba uvifera		7			7	5	1	
Bumelia celastrina		7			7	5	1	
Guettarda scabra		7			7	5	1	
Acacia peninsularis		7			7	5	1	*
Lantana involucrata	7				7	5	1	
Rapanea guianensis	7				7	5	1	
Ficus brevifolia		7			7	5	1	
Totals	2200	3672	907	319	7098			

Fig. 1. Upper 1951 photograph; lower 1970 photograph. Note the difference in young pines.

number of pines over twelve feet tall. Two hurricanes (1960 and 1965) affected the area, and there were many fires prior to 1951 that weakened the older trees. Tree falls and standing dead trunks

are not uncommon. Figure 1 gives a fairly accurate picture of the increase in young pines. The photographs were taken at the same location.

Palms account for a great percentage of the total plant cover. *Coccothrinax argentea,* silver palm, totals are reduced considerably in the 1969 data. This is strongly reflected in the seedling count. At the same time more large specimens were counted. For some reason(s), the current reproductive rate is definitely less than during the period preceding the 1951 study. *Thrinax microcarpa,* key thatch palm, increased about three times during the 18 years and appears to be reproducing at a steady rate as evidenced by the first three size classes being well represented in the population. *Serenoa repens,* saw palmetto, appears to be failing significantly. This is considered a sampling problem. It is still locally abundant, especially near the depressions in the limestone. These limestone sinks were not encountered when plots were positioned in 1969.

Pithecolobium guadelupense, slightly increased its significance in the habitat. *Byrsonima cuneata* was very stable in density but reduced in frequency. *Eugenia longipes* remained the same in cover but only half as many seedlings were found in 1969. *Metopium toxiferum* increased in cover and frequency, but showed a drastic drop in seedlings in 1969. *Randia aculeata* and *Pisonia rotundata* appear to be failing. Small *Erithalis* plants were so closely cropped that they were hard to identify and larger plants were browsed as high as the deer could reach.

The differences between the totals in Table 1 and 2 are as follows. There were 2,371 fewer woody plants per acre at the end of the observation period than at the start. There were fewer tall pine trees. There was an increase of about 500 individuals per acre in the 4′-12′ class. This increase reflects the growth rate. The datum on the under-one-foot class is considered very significant in that there were 2,739 fewer individuals per acre in 1969. This is more than a 50 per cent reduction from the 1951 counts. Three possible reasons are; lack of fire, drought occurrence and new mosquito ditches.

According to the Refuge records none of the quadrat sites was burned after 1951. However, fire has been common in the pineland prior to that time. Seedlings of many species are frequently com-

TABLE 3

1969-70 Understory Plant List

Acacia peninsularis	*Houstonia* sp.
Anemia adiantifolia	*Hypericum* sp.
Borreria terminalis	*Melanthera parvifolius*
Cassytha filiformis	*Mikania batatifolia*
Centrosema virginianum	*Morinda roioc*
Chamaecrista keyensis	*Phyllanthes pentaphyllus*
Chamaesyce conferta	*Physalis angustifolia*
Chamaesyce serpyllum	*Piriqueta* sp.
Chiococca pinetorum	*Pluchea foetida*
Chrysobalanus pallidus	*Polygala* sp.
Cirsium horridulum	*Polygala praetervisa*
Caladium jamaicense	*Pterdium aquilinum*
Cnidoscolus stimulosus	var. *caudatum*
Crotalaria maritima	*Pterocaulon undulatum*
Croton linearis	*Rhabdadenia corallicola*
Cynanchium blodgettii	*Rhacoma ilicifolia*
Dichromena colorata	*Rhynchosia parvifolia*
Ernodea angusta	*Ruellia hybrida*
Flaveria linearis	*Smilax havanenensis*
Galacti parvifolia	*Stylosanthes hamata*
Galium hispidulum	*Tragia saxicola*
Gerardia purpurea	Unknown (one)
Heliotropium leavenworthii	Grasses (several)

mon following fire and then the numbers decline. The rainfall record from the nearest station (Key West) shows that for the 10 years prior to the 1951 study the rainfall was close to their 36-year average of 37.6 inches a year. The study period years, 1951, '55, '56, and '61 were drought years. Owing to the rocky and almost soilless condition of the limestone surface, even moderate droughts could kill seedlings before establishment. In January of 1964 the Monroe County Mosquito Control District began a ditching program on Big Pine. By completion in December of 1965, a total of 4,976 acres (of about 6000) had been ditched (personal communication from Director J. V. Denis, Monroe County Mosquito Control District, Stock Island, Florida, 1971). These ditches are about sixteen inches wide, vertical-sided, and are deep enough to allow tide water to flow in them from the nearby open sea. This increases salt intrusion into the substrate and also increases the rate of rainwater runoff, thus reducing penetration of fresh water to the root zone. Both of

TABLE 4
Comparison of Common Understory Species

Species	1951 F	1951 D	1951 C	1969 F	1969 D	1969 C	Deer Food
Species Occurring in Top 15 on Both Sampling Dates							
1. Grass spp.	93	8.3	4	83	9.7	3	
2. *Chamaecristas keyensis*	37	0.9	3	72	3.0	2	
3. *Ruellia hybrida*	37	0.8	1	53	1.2	1	*
4. *Dichromena colorata*	27	0.9	1	47	2.0	2	
5. *Galactia parvifolia*	20	0.2	1	43	0.8	1	*
6. *Cassytha filiformis*	23	0.2	1	30	0.3	1	*
7. *Morinda roioc*	13	0.6	1	27	0.5	2	*
8. *Phyllanthes pentaphyllus*	23	0.2	1	27	0.6	2	
9. *Smilax havanensis*	23	0.4	1	23	0.5	1	*
1951 Species New to Top Fifteen in 1969							
10. *Melanthera parvifolius*	3	0.1	1	40	0.7	1	
11. *Ernodea angusta*	7	0.1	1	33	1.0	3	
12. *Anemia adiantifolia*	7	0.3	1	30	0.9	2	
13. *Crotalaria maritima*	7	0.1	1	30	0.8	1	*
14. *Polygala grandifloria*	3	0.1	1	30	0.4	1	
15. *Cirsium horridulum*	3	0.1	1	27	0.3	1	
Species in Top Fifteen in 1951 but not in 1969							
Gerardia purpurea	23	0.5	2	13	0.3	1	*
Croton linearis	20	0.3	3	13	0.2	1	
Chamaesyce scoparia	17	0.3	1	—	—	–	*
Flavaria linearis	13	0.3	1	17	0.2	1	
Pterocaulon undulatum	13	0.1	1	20	0.4	1	
Physalis angustifolia	10	0.4	1	3	0.1	1	*

(F=frequency, D=density, and C=cover.)

these conditions contribute to water stress on the plants. Water for survival is critical in this rocky and xerophytic pineland.

The understory species are mostly herbaceous. However, some like *Ernodea* and *Morinda roioc* become woody. In general, all understory species listed were less than a half meter tall. The 1951 list included 46 species; the 1969 included 45. Twelve species listed in 1951 did not appear in 1969. Eleven species listed in 1969 did not appear in 1951. These differences, in part, are probably due to seasonal differences in sampling. Table 3 is a complete alphabetical listing of understory plants for 1969. Table 4 summarizes the major changes that occurred and includes all plants that are prominent understory species. All of the other species listed in Table 3 occur

with a frequency of only 13 per cent or less and belong to cover class 1.

The data reflect a fairly stable population in the understory for the 18-year period. The range and extent of changes do not appear unusual for this habitat. Grasses are somewhat less common in 1969. This is probably due to shading, especially from the increasing height of the palm and shrub canopy and the lack of fire. The most obvious change in the understory is the increased amount of *Ernodea*. This vine-like shrub with prostrate branches grows in dense mats and can dominate sizeable areas.

The pineland has not changed in overall appearance as much as the northern prairie did under similar conditions and time (Alexander and Dickson, 1970). In the latter case, plant succession proceeded from an open prairie to the thicket stages of a climax forest. The moisture holding marl soil of the prairie as compared to the rocky dry soil of the pineland was probably the main factor in the differences in the rate of succession seen in these contiguous areas. The pineland is on a mass of limestone and roots are restricted mostly to the accumulated organic litter and a few shallow solution holes. Soil forming processes are slow in this environment and fires burn accumulated organic litter so that large areas of bare rock are repeatedly exposed.

That there is a rich assortment of species and their propagules to initiate succession is well documented by this study and the plant lists from previous studies (Dickon, Woodbury, Alexander, 1953; Dickson, 1955; and Franklin, 1968). In spite of the above edaphic restrictions on succession the pineland of the Keys will give way to the climax of broad-leaved West Indian species if given enough time (Alexander, 1958, 1967). This has been documented by Stern and Brizicky (1957) on nearby No Name Key and by Dickson (1955) on No Name and Little Pine Keys. Prolonged protection from fire was the major factor on both Keys. Based on the evidence from this study and Jack Watson's (Refuge Manager) estimate in 1970 of fire-free years on most of No Name Key, it took about 50 years for broad-leaved species to completely overcome the pine forest and limit its reproduction. This is about twice the time for similar stages to be reached on the mainland (Alexander, 1967). Deer-use of the open pineland on Big Pine Key indicates the desirability

of this type of habitat in the Refuge and fire is a natural means of maintaining an open pineland.

The use of fire for controlling and maintaining vegetation such as pinewoods is well established (Mutch, 1970). That fire improves the growing condition of deer browse species was observed in the earlier study (Alexander and Dickson, 1970). It is also known that a pineland with accumulated fuel of leaf litter and undergrowth is vulnerable to crown fire and death of the forest. Only a few references on the response of *Pinus elliottii* to fire could be found and these were for var. *elliottii* instead of the local var. *densa* (Fowells, 1965). Hayward and Barnetti (1936) stated . . . "it has been established as a fact that the highly desirable slash pine *P. caribaea* More. (now *P. elliottii*) reproduces only on areas protected from fire." This statement was expanded and clarified in a more recent report by Gruschow (1952). The latter has data showing that successfully controlled burning on young stands of this pine is not started until the trees are about 12 feet tall. Trees smaller than this will suffer serious setbacks. Kaufman stated that "for natural regenerations of slash pine (*Pinus elliottii* var. *elliottii* and var. *densa*), burning to prepare the seedbed is a common practice. After the seeds have fallen to the soil surface, until the young trees have achieved some size, fire can destroy all efforts for regeneration. Usually controlled burning in young stands is not started until the trees are two inches at d.b.h. (diameter at breast height 4 1/2 ft. above the soil surface) and about 15 feet tall. Under very optimum conditions, slash pine much smaller will successfully survive very carefully conducted controlled burning but the risks increase very much. The *densa* (South Florida) variety of slash pine is somewhat more fire tolerant than the *elliottii* variety" (personal communication from Professor C. M. Kaufman, School of Forestry, University of Florida, Gainesville, Florida, 1970).

It should be noted that the *densa* variety has not been subjected to the same management by fire as has the *elliottii* variety. Also there is the fact that much of what is known about the latter's reaction to fire has been learned in row-planted pines and in the flatwoods of mainland Florida. Not much is known about the reaction of the key-type pineland to fire. Historically, the Keys have suffered many wildfires. Fires have undoubtedly served to maintain the pineland and arrest succession throughout recent time.

Before completion of this manuscript, wildfire burned about 340 acres of pineland on Big Pine Key, June 5, 1971. The authors examined the burn on July 9. The purpose was to evaluate the effect on the local *densa* variety. The observations support the previously reported results given for the *elliottii* variety. Most of the trees of the 4′-12′ class and under were dead, except where for some reason the heat was not excessive. It should be noted that the area had been fire-free for 20 years or more and the fuel load was excessive. Most palms were recovering and many of the woody plants were sprouting from their root-crowns.

It has been reported that a pineland once existed on Key Largo (Alexander, 1953). Only a few of the pineland related species persist on this Key. This part of Key Largo has been fire-free for many decades and is now covered by a dense forest of West Indian broad-leaved species. These observations indicate the pineland can be lost by total protection from fire as well as by ill-timed and severe burnings.

The problem becomes especially critical in the Refuge since the land mass is so small. Wildfire can be replaced by controlled burning. Proper periodicity of burns can be determined only by regularly conducted vegetation studies coupled with the need to maintain adequate deer browse.

LITERATURE CITED

ALEXANDER, TAYLOR R. 1953. Plant succession on Key Largo, Florida, involving *Pinus caribaea* and *Quercus virginiana*. Quart. Jour. Florida Acad. Sci., vol. 16, no. 3, pp. 133-138.

———. 1958. High hammock vegetation of the southern Florida mainland. Quart. Jour. Florida Acad. Sci., vol. 21, no. 4, pp. 293-298.

———. 1967. A tropical hammock on the Miami (Florida) Limestone—A twenty-five-year study. Ecology, vol. 48, no. 5, pp. 863-867.

ALEXANDER, TAYLOR R., AND JOHN D. DICKSON III. 1970. Vegetational changes in the National Key Deer Refuge. Quart. Jour. Florida Acad. Sci., vol. 33, no. 2, pp. 81-89.

DICKSON, JOHN D., III, R. O. WOODBURY, AND T. R. ALEXANDER. 1953. Check-list of flora of Big Pine Key, Florida and surrounding Keys. Quart. Jour. Florida Acad. Sci., vol. 16, no. 3, pp. 181-197.

DICKSON, JOHN D., III. 1955. An ecological study of the Key deer. Florida Game and Fresh Water Fish Commission, Tech. Bull., no. 3, 104 pp.

FOWELLS, H. A. 1965. Silvics of Forest Trees of the United States. Agriculture Handbook, no. 271, U.S.D.A. Forest Service, pp. 458-463.

FRANKLIN, ALICELIA H. 1968?). List of plants on Big Pine Key, Florida. Report to the Bureau of Sport Fisheries and Wildlife—distributed as PB 180221 by Clearinghouse for Federal Scientific and Technical Information, Springfield, Va.

GRUSCHOW, GEORGE F. 1952. Effect of winter burning on growth of slash pine in the flatwoods. Jour. Forestry, vol. 50, no. 7, pp. 515-517.

HEYWARD, FRANK AND R. M. BARNETTE. 1936. Field characteristics and partial chemical analysis of the humus layer of longleaf pine forest soils. Tech. Bull. 302, University of Florida, Agric. Exp. Sta., 27 pp.

LAKELA, OLGA, AND F. C. CRAIGHEAD. 1965. Annotated checklist of the vascular plants of Collier, Dade, and Monroe, Counties, Florida. Fairchild Tropical Garden and University of Miami Press, Coral Gables, Florida, 95 pp.

MUTCH, ROBERT W. 1970. Wildland fires and ecosystems—a hypothesis. Ecology, vol. 51, no. 6, pp. 1046-1051.

STERN, WILLIAM L., AND G. K. BRIZICKY. 1957. The woods and flora of the Florida Keys—Introduction Tropical Woods, no. 107, pp. 36-65.

Biology Department, University of Miami, Coral Gables Florida 33124; Vining C. Dunlap Laboratories, Tela Railroad Co. (Subsidiary of United Fruit Co.), La Lima, Honduras, C.A.

Quart. Jour. Florida Acad. Sci., 35(2) 1972(1973)

Composition of *Thalassia testudinum* and *Ruppia maritima*

Gerald E. Walsh and Thomas E. Grow

Little is known at present about the nutritive value of aquatic plants, especially in relation to annual variations in their chemical constituents. Turtle grass (*Thalassia testudinum*) and widgeon grass (*Ruppia maritima*) are common in the inshore waters of Florida (Phillips, 1960). They are important constituents of estuarine nursery grounds for marine animals and many forms of plant and animal life are associated with them (Hudson et al., 1970). The seagrasses are eaten by fishes, turtles, and other aquatic animals (Randall, 1965), and birds (Olney, 1968). Detritus derived from seagrasses is eaten by small marine animals (Menzies and Rowe, 1969; Fenchel, 1970. Also, *T. testudinum* and its epiphytes are important in biogeochemical cycles in estuarine areas (Parker, 1966).

Both *T. testudinum* and *R. maritima* have been used successfully in preliminary experiments as fertilizers for tomatoes (van Breedveld, 1966) and as feed supplements for Sheep (Bauersfeld et al., 1969).

Because of the importance of *T. testudinum* and *R. maritima* to estuarine ecosystems, we investigated seasonal distributions of protein, carbohydrate, trace elements, and energy content of their leaves and rhizomes. Also, the potential nutritive value of the seagrasses was evaluated.

Methods

Thalassia testudinum and *R. maritima* were collected between 6 June 1969 and 27 May 1970 from a mixed bed at the western edge of Sabine Island in Santa Rosa Sound near Gulf Breeze, Florida. They were taken in the morning to avoid possible diel variation in the factors measured. Abundance of *R. maritima* was greatly reduced in February 1970 and enough plant material could not be collected for all tests.

After collection, plants were taken immediately to the laboratory, where the epiphyton was removed. The leaves were separated from the rhizomes and all were washed quickly in a stream of distilled

water. Leaves and roots were dried to constant weight in an oven at 100 C and ground in a Wiley mill to pass the 40-mesh sieve. The pulverized material was stored *in vacuo* over anhydrous calcium carbonate until tested.

Ash content was determined by combustion in a muffle furnace at 55 C for five hours.

Total protein was measured by the method of Strickland and Parsons (1965) using acetonylacetone (2,5-hexanedione) reagent and the procedure was standardized against the Kjeldahl-Nessler method. We report protein content as percentage of dry weight and of ash-free dry weight.

Total carbohydrate was measured by a variation of the anthrone method for particulate carbohydrate (Strickland and Parsons, 1965). Fifty mg of each sample were suspended in 50 ml of 0.2 N H_2SO_4 in a 125-ml Erlenmeyer flash. The sample was hydrolysed at 100 C for 90 min. with mixing every 15 min. The hydrolysate was passed through a glass-fiber filter of 0.45μ porosity and 0.2 ml of the filtrate was pipetted into a test tube. To this was added 10.8 ml of anthrone reagent (0.2 g anthrone, 8.0 ml 95 per cent alcohol, 30.0 ml distilled water, and 100 ml concentrated H_2SO_4). The solution was heated at 100 C for five min. and brought quickly to room temperature in an ice-water bath. After 15 min. the extinction was measured against distilled water at 6200 A in a one-cm glass cell in a Beckman DU spectrophotometer. Glucose was used in preparation of standard carbohydrate solutions. The data are expressed as percentage carbohydrate in dry weight and in ash-free dry weight.

Concentrations of sodium, potassium, magnesium, iron, manganese, and zinc in leaves and rhizomes were measured by atomic absorption spectroscopy, using a modification of the method of David (1958). Approximately 0.01 g of dried plant material was placed in a 30 ml Kjeldahl digestion flask with two ml of a 1:7 sulphuric acid-perchloric acid mixture and 10 to 12 ml of nitric acid. Digestion was continued until organic matter was completely destroyed. Four glass beads were added to each flash to prevent bumping.

After digestion, the flash was cooled to room temperature and three ml of distilled water added. After gentle shaking, the contents were transferred to a 25-ml volumetric flask. This washing procedure was repeated twice with five ml of distilled water and the

hydrolysate taken to 25 ml with distilled water. The hydrolysate was analyzed on a Beckman Model 1301 atomic absorption unit equipped with a Beckman DB-G spectrophotometer. Concentrations of the elements are reported as parts per thousand (ppt) of dry weight.

Caloric contents were determined on a Parr Series 1200 adiabatic calorimeter. Fuse wire and acid corrections were made for each determination and results are expressed as kilocalories per gram of ash-free dry weight.

RESULTS AND DISCUSSION

Ash. Annual mean values and ranges of values for ash, protein, carbohydrate, and energy are given in Table 1. Annual variation in ash content was not found and analysis of variance indicated that all mean values were significantly different at the 0.05 level. The

TABLE 1

Annual means for ash, protein, carbohydrate, and energy contents of *Thalassia testudinum* and *Ruppia maritima* between June 1969 and May 1970.

Component	Annual mean	Range
Ash, % dry weight		
T. testudinum leaves	24.5	20.6-26.9
T. testudinum rhizomes	23.8	21.4-25.4
R. maritima leaves	18.8	15.8-23.8
R. maritima rhizomes	22.4	18.6-24.8
Protein, % ash-free dry weight		
T. testudinum leaves	25.7	13.6-37.1
T. testudinum rhizomes	11.0	7.7-14.7
R. maritima leaves	23.2	13.5-32.6
R. maritima rhizomes	20.0	14.1-26.9
Carbohydrate, % ash-free dry weight		
T. testudinum leaves	23.6	18.3-35.8
T. testudinum rhizomes	72.1	54.5-80.3
R. maritima leaves	27.0	24.3-34.3
R. maritima rhizomes	63.6	52.0-73.3
Energy, Kcal/g ash-free dry weight		
T. testudinum leaves	4.66	4.47-4.79
T. testudinum rhizomes	4.88	4.76-5.16
R. maritima leaves	4.44	4.28-4.69
R. maritima rhizomes	4.25	4.09-4.38

values obtained for ash contents were similar to those for most other aquatic plants (Westlake, 1965) and for leaves of *T. testudinum* (Burkholder et al., 1959).

Protein. There was considerable annual variation in the amount of protein in ash-free dry weight of leaves. The highest value found for *T. testudinum* leaves was 2.7 times that of the lowest, while that for *R. maritima* leaves was 2.4 times greater. Annual variation in

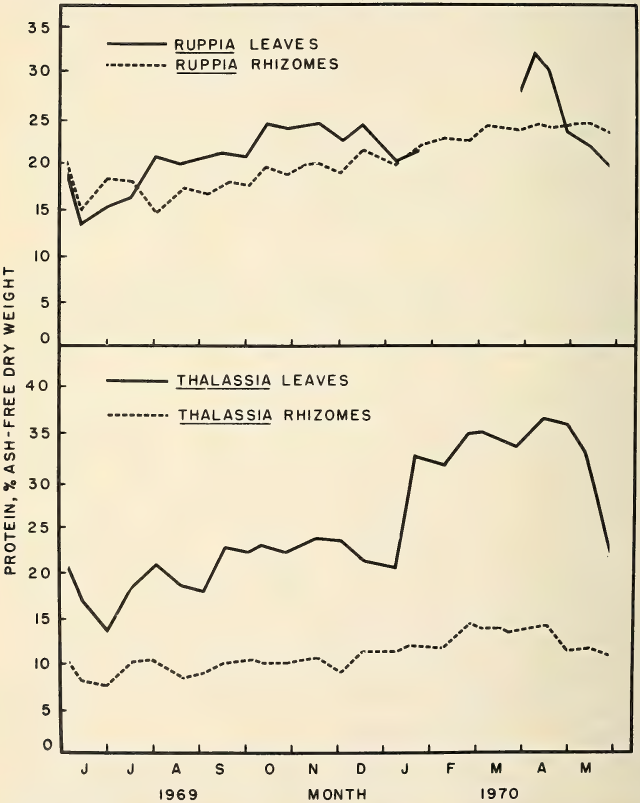


Fig. 1. Annual variation of protein in *Thalassia testudinum* and *Ruppia maritima.*

protein in underground parts was less. In both *T. testudinum* and *R. maritima,* the highest concentration in the rhizomes was 1.9 times that of the lowest.

During the annual cycle, the protein content of the leaves of *T. testudinum* was always greater than that of the rhizomes (Figure 1), the annual mean concentration in leaves being over two times larger (Table 1). Concentration of protein in the leaves of *T. testudinum* increased in the late winter and spring between 9 January and 16 April. Concentrations decreased rapidly thereafter, and were lowest in summer on 2 July 1969. In the rhizomes, however, concentrations of protein increased only slightly between 26 February and 16 April 1970, and fell less precipitously than did those of the leaves.

The annual mean concentration of protein in the leaves of *R. maritima* was slightly greater than that in the rhizomes, but concentration was greater in the rhizomes in the summer months of May, June, and July. Concentrations in the leaves reached a peak on 8 April 1970, and fell rapidly thereafter. Lowest concentration was found in the summer on 4 August 1969. Concentration of protein in the rhizomes of *R. maritima* rose slowly in the nine-month period between 4 August and 14 May, with lowest concentrations occuring in summer in June and early August.

The above findings are related to the functional aspects of leaves and rhizomes. Leaves generally have a greater amount of protein than rhizomes because they are largely concerned with biosynthesis and, consequently, contain large amounts of enzymes and many membranes. However, rhizomes are storage organs and contain relatively large amounts of carbohydrate, as will be shown later. Leaf protein is greatest in spring when biosynthesis is rapid, whereas concentrations of carbohydrate in rhizomes are greatest in fall and winter.

Bauersfeld et al. (1969) suggested that *T. testudinum* may be of value as a feed additive for domestic animals. They reported that the leaves of *T. testudinum,* after a single washing with distilled water, contained between 9.0 and 14.1 per cent protein on a dry weight basis, whereas the rhizomes contained 15 per cent. Burkholder et al. (1959) reported that the dried leaves of *T. testudinum* contained 13.1 per cent protein. Neither study, however, reported the dates on which samples were taken.

On a percentage dry weight basis, the protein contents of our samples were: *T. testudinum* leaves, 10.3-29.7; rhizomes, 5.8-12.2; *R. maritima* leaves, 10.9-28.5; rhizomes, 10.4-18.1. These values are, in general, higher than those for many other plants. Among the

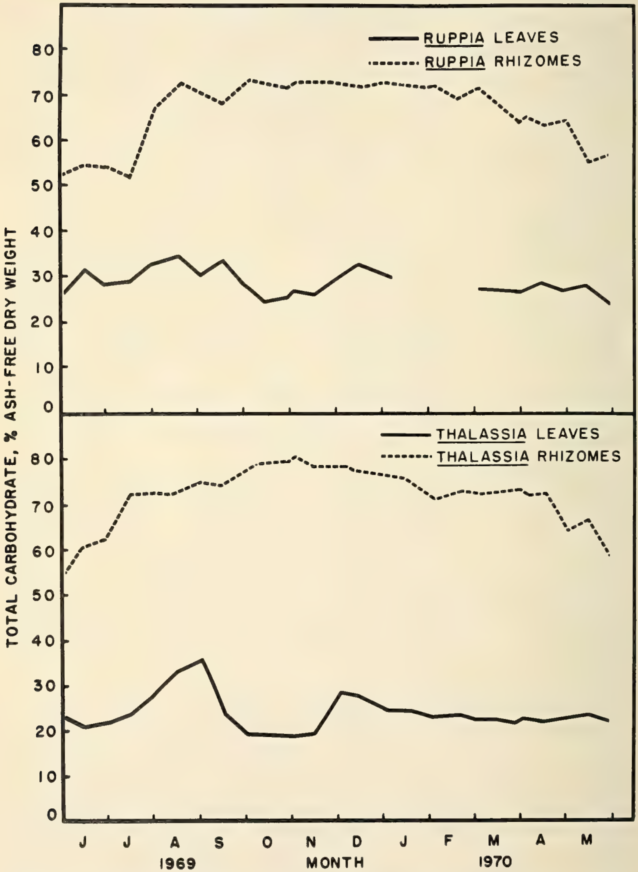


Fig. 2. Annual variation of carbohydrate in *Thalassia testudinum* and *Ruppia maritima*.

aquatic plants, *Myriophyllum* sp. contained approximately 7.8 per cent protein in dry weight (Oelshlegel, 1969) and *Spartina alterniflora* 8.9 per cent (Hall et al., 1970). Boyd (1970), in a study of the protein content of 11 freshwater species, reported a range of from 4.0 per cent (*Typha latifolia*) to 21.6 per cent (*Nuphar advena*). Yee (1970) reported 17.5 per cent protein in *Hydrilla* sp. and 30.5 per cent in *Pistia stratoides.* Among foodstuffs, 114 lines of corn contained 9.8-16.3 per cent protein (Davis et al., 1970), 49 varieties of grain sorghum contained 8.6-16.5 per cent (Virupaksha and Sastry, 1968) and wheat grain between 8.3-12.4 per cent (Chrominski, 1967).

Though high in protein, it is doubtful that these seagrasses could be used directly as food by humans. The unanimous consensus of a taste panel at the Gulf Breeze laboratory was that dried leaves and rhizomes are gritty, and have a strong, unpleasant odor and flavor.

Carbohydrate. In contrast to protein contents, carbohydrate contents of rhizomes were greater than those of leaves (Table 1) because rhizomes are storage organs for starch. Fig. 2 shows that the carbohydrate contents of rhizomes, as percentage ash-free dry weight, began to rise in July due to production and storage in summer, and attained peak concentrations in October and November. Decrease in spring was probably due to utilization of stored carbohydrate for biosynthesis and respiration.

The carbohydrate contents of the seagrasses tested were similar to those of other plants. As percentage dry weight, *T. testudinum* leaves contained between 12.5 and 25.5 per cent carbohydrate, whereas the rhizomes contained between 41.5 and 62.9 per cent. Leaves of *R. maritima* contained between 20.0 and 27.2 per cent and rhizomes between 35.8 and 55.1 per cent carbohydrate. Reported values for other plants, as percentage dry weight, are: alfalfa, 13-25 (Raguse and Smith, 1965, 1966; Grotelueschen and Smith, 1967); red clover, 14-21 (Raguse and Smith, 1966), and timothy, 48 (Grotelueschen and Smith, 1967). Most of the values for seagrasses were within these ranges.

Energy. The energy contents (Table 1) of all samples were very similar to those reported for most other plants (Cummings, 1967) and no annual trends were observed.

Elements. Annual variations in concentrations of sodium, potas-

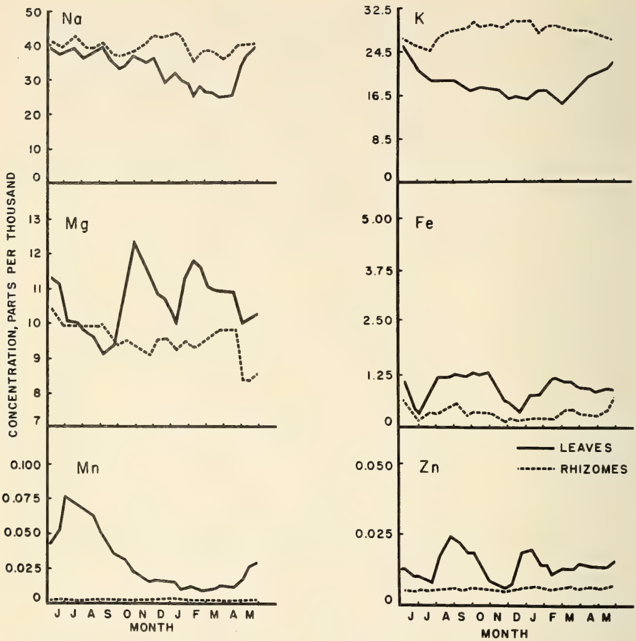


Fig. 3. Annual variations of some elements in *Thalassia testudinum.*

sium, magnesium, iron, manganese, and zinc are shown in Figures 3 and 4. The variations appear to be associated with age and functional aspects of the materials analyzed.

In several aquatic macrophytes, concentrations of some elements decline with age. For example, concentrations of nitrogen, phosphorus, sulfur, calcium, and potassium decline with age in *Typha latifolia* and in the bulrush *Scripus americanus* (Boyd, 1970). Concentrations of zinc, manganese and iron are lowest in mature *Spartina alterniflora* (Williams and Murdock, 1969), and the authors suggested that the decrease may be due to dilution of actively growing tissues by structural material which contained little of the elements measured.

Table 2 gives concentrations of the elements found in the leaves

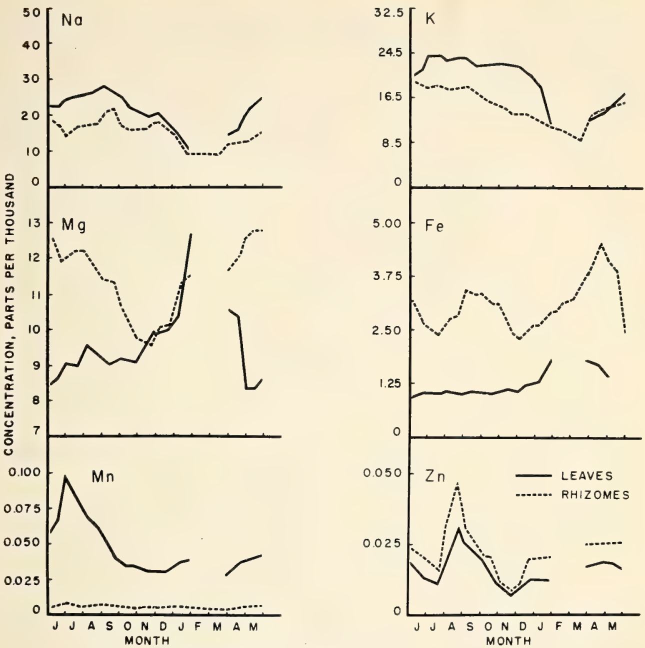


Fig. 4. Annual variation of some elements in *Ruppia maritima.*

and roots of selected plants. Concentrations in the seagrasses were always within ranges given in the table, even though annual variation was found for each element. Concentrations of zinc, manganese, and iron were also similar to those reported for *S. alterniflora* by Williams and Murdock (1969).

We cannot yet explain why the observed variations occurred because little is known about the multiple roles of each element during the year. For example, magnesium is a structural component of chlorophyll, but it was often in higher concentrations in rhizomes than in leaves. This was probably related to the fact that it is also a specific cofactor for many enzymes involved in carbohydrate metabolism and its concentration depends upon age and seasonal variation in physiology of the plant part.

TABLE 2

Concentrations, in parts per thousands, of some elements in the leaves and roots of selected plants.

Plant	K	Mg	Fe	Mn	Zn
Carrot					
leaves	13.3	2.8	0.36–0.77	0.02–0.20	0.03
roots	16.8–59.2	1.2–2.4	0.04–0.49	0.01–0.09	0.01
Soybean					
leaves	8.0	7.9	0.34	0.03–0.19	0.10
roots	14.4–15.6	10.7–31.8	–	0.02–0.15	–
Sunflower					
leaves	16.2–19.0	11.0	–	0.07–1.27	–
roots	13.6–38.0	1.3–12.7	0.03	–	0.02
Sweet potato					
leaves	16.1–23.7	4.5–5.4	–	–	–
roots	6.8–17.4	0.6–2.1	0.01–0.14	0.01–0.03	0.01
Tomato					
leaves	5.2–37.6	6.2–15.5	0.28–0.54	0.05–4.93	0.03
roots	8.0–34.1	4.6	–	–	–

From Altman, P. L. and D. S. Dittmer (eds.), Biology Data Book, 1964.

In summary, in relation to other aquatic plants and food crops, *T. testudinum* and *R. maritima* contain significant amounts of protein, carbohydrate, energy, and minerals. The nutritive value of *T. testudinum* has been established (Bauersfeld et al., 1969) and that of *R. maritima* is implied from the work reported here. Annual variation in chemical composition, however, implies that the nutritional value of seagrasses varies throughout the year.

LITERATURE CITED

ALTMAN, P. L., AND D. S. DITTMER (eds.). 1964. Biology data book. Federation of American Societies for Experimental Biology, Washington, D. C., xix + 633 pp.

BAUERSFELD, P., R. R. KIFER, N. W. DURANT, AND J. E. SYKES. 1969. Nutrient content of turtle grass (*Thalassia testudinum*). Proc. Intl. Seaweed Symp., vol. 6, pp. 637-645.

BOYD, C. E. 1970. Amino acid, protein, and caloric content of vascular aquatic macrophytes. Ecology, vol. 51, pp. 902-906.

BURKHOLDER, P. R., L. M. BURKHOLDER, AND J. A. RIVERO. 1959. Some chemical constituents of the turtle grass *Thalassia testudinum*. Bull. Torrey Bot. Club, vol. 86, pp. 88-93.

CHROMINSKI, A. 1967. Effect of (2-chloroethyl) trimethylammonium chloride on protein content, protein yield, and some qualitative indexes of winter wheat grain. Jour. Agr. Food Chem., vol. 15, pp. 109-112.

CUMMINGS, K. W. 1967. Calorific equivalents for studies in ecological energetics. Pymanting Laboratory of Ecology, University of Pittsburgh. 2nd. ed., 52 pp.

DAVID, D. J. 1958. Determination of zinc and other elements in plants by atomic absorption spectroscopy. Analyst., vol. 8, pp. 655-661.

DAVIS, L. W., W. P. WILLIAMS, JR., AND L. CROOK. 1970. Interrelationships of the protein and amino acid contents of inbred lines of corn. Jour. Agr. Food Chem., vol. 18, pp. 357-360.

FENCHEL, T. 1970. Studies on the decomposition of organic detritus derived from the turtle grass *Thalassia testudinum*. Limnol. Oceanogr., vol. 15, pp. 14-20.

GROTELUESCHEN, R. D., AND D. SMITH. 1967. Determination and identification of nonstructural carbohydrates removed from grass and legume tissue by various sulfuric acid concentrations, takadiastase, and water. Jour. Agr. Food Chem., vol. 15, pp. 1048-1051.

HALL, K. J., W. C. WEIMER, AND G. F. LEE. 1970. Amino acids in an estuarine environment. Limnol. Oceanogr., vol. 15, pp. 162-164.

HUDSON, J. H., D. M. ALLEN, AND T. J. COSTELLO. 1970. The flora and fauna of a basin in Central Florida Bay. U. S. Fish Wildl. Ser. Spec. Sci. Rep. Fish. 604, pp. 1-14.

MENZIES, R. J., AND G. T. ROWE. 1969. The distribution and significance of detrital turtle grass, *Thalassia testudinum*, on the deep-sea floor off North Carolina. Int. Rev. Ges. Hydrobiol., vol. 54, pp. 217-222.

OELSHLEGEL, F. J., JR. 1969. Potential for protein concentrates from alfalfa and waste green plant material. Jour. Agr. Food Chem., vol. 17, pp. 665-668.

OLNEY, P. J. S. 1968. The food and feeding habits of the pochard, *Aythya ferina*. Biol. Conserv., vol. 1, pp. 71-76.

PARKER, P. L. 1966. Movement of radioisotopes in a marine bay: cobalt-60, iron-59, manganese-54, zinc-65, sodium-22. Publ. Inst. Mar. Sci., Univ. Texas, vol. 11, pp. 102-107.

PHILLIPS, R. C. 1960. Observations on the ecology and distribution of the Florida seagrasses. Florida State Bd. Conser., Prof. Papers Ser., No. 2, St. Petersburg, iv + 72 pp.

RAGUSE, C. A., AND D. SMITH. 1965. Carbohydrate content in alfalfa herbage as influenced by methods of drying. Jour. Agr. Food Chem., vol. 13, pp. 306-309.

———. 1966. Some nonstructural carbohydrates in forage legume herbage. Jour. Agr. Food Chem., vol. 14, pp. 423-426.

RANDALL, J. E. 1965. Grazing effect on seagrasses by herbivorous reef fishes in the West Indies. Ecology, vol 46, pp. 255-260.

STRICKLAND, J. D. H., AND T. R. PARSONS. 1965. A manual of sea water analysis, 2nd ed. Fish. Res. Bd. Canada. Bull. No. 125. Ottawa, viii + 203 pp.

VAN BREEDVELD, J. F. 1966. Preliminary study of seagrass as a potential source of fertilizer. Florida State Bd. Conser., Mar. Lab. Spec. Sci. Rep. 9, pp. 1-20.

VIRUPAKSHA, T. K., AND L. V. S. SASTRY. 1968. Studies on the protein content and amino acid composition of some varieties of grain sorghum. Jour. Agr. Food Chem., vol. 16, pp. 199-203.

WESTLAKE, D. F. 1965. Some basic data for investigations of the productivity of aquatic macrophytes. *In*: C. R. Goldman (ed.), Primary Productivity in Aquatic Environments. Mem. Ist. Ital. Idrobiol., 18 Suppl., University of California Press, Berkeley, pp. 229-248.

WILLIAMS, R. B., AND M. B. MURDOCK. 1969. The potential importance of *Spartina alterniflora* in conveying zinc, manganese, and iron into estuarine food chains. *In* D. J. Nelson and F. C. Evans (eds.), Symposium on Radioecology, 2nd Nat. Symp., Ann Arbor, Michigan, pp. 431-439.

YEE THONG TAN. 1970. Composition and nutritive value of some grasses, plants, and aquatic weeds tested as diets. Jour. Fish. Biol., vol. 2, pp. 253-257.

Gulf Breeze Environmental Research Laboratory, Sabine Island, Gulf Breeze, Florida 32561. An associate laboratory of the National Environmental Research Center, Corvallis, Oregon. Contribution No. 126.

Quart. Jour. Florida Acad. Sci 35(2) 1972(1973)

Noteworthy Marine Fishes from Eastern Louisiana

Jerry G. Walls

Over the last ten years, a small collection of local fishes has accumulated at the Louisiana Wild Life and Fisheries Comm. Marine Biology Laboratory on Grand Terre Island, Louisiana. Many of the specimens were collected incidental to shrimp studies and saved for later identification. Although most came from Barataria Bay, many were collected between 15 and 25 miles south of Grand Isle, where average depths of 15 to 25 fathoms occur. A few other specimens were donated by charter boat captains who found their catches to be of unusual interest. Although often poorly preserved, some specimens in this collection are noteworthy and are reported here.

1. *Hemanthias vivanus* (Jordan and Swain). Red barbier. Three specimens of this beautiful fish were caught on 4 Dec. 1970, by Mr. Jess Lane, while fishing with squid bait for red and vermilion snapper. They were caught near Rig 122-C, southeast of Grand Isle near the Mississippi River delta, at a depth of 260 feet. All three specimens were of similar size. Data on the single available specimen follow: total length 343 mm; standard length, 257; depth at anal base, 87.5; head, 85.5; snout, 27.5; eye, 19; interorbital, 19.5; upper caudal lobe, 72; lower caudal lobe, 79; left ventral, 134; pectoral, 62; caudal peduncle depth, 40; dorsal spines: 1st, 10; 2nd, 20; 3rd, 72; 4th, 27; 7th, 22; 10th, 17.5; first dorsal ray, 26; first anal spine, 11; second, 20.5; third, 23 mm. D. X, 13; A. III, 8; P_1, 17-18; P_2, I, 5; pored Ll. scales, 52; GR, lower limb, 26. This specimen was a mature male with large (55 mm long), firm testes. The peritoneum was white; stomach contents consisted of a small amount of blue-gray mud and a packet of very small, silvery fish scales; the gas bladder was expanded into the mouth.

Of Gulf of Mexico anthiids, only *Hemanthias vivanus* and *H. leptus* resemble the present specimen. Louis R. Rivas (*in lit.*, Feb., 1971) separates *H. vivanus* from *H. leptus* by more gill rakers (30 in *H. vivanus* vs. 26 in *H. leptus*), fewer pored lateral line scales (48-50 vs. 55), elongated, flexible third dorsal spine (pungent and of normal length in *H. leptus*), and the absence of a deeply lunate caudal fin (deeply lunate in *H. leptus*). The present specimen agrees with *H. vivanus* in the prolonged dorsal spine and nearly

truncate caudal fin; the scale count is intermediate, and the gill raker count fits *H. leptus*. Available descriptions of these species (Jordan and Evermann, 1896; Longley and Hildebrand, 1940, 1941; Ginsburg, 1952) are confusing and provide little information of value. The confusing aspects of the Louisiana specimen may be due to normal variation and to sex or degree of maturity. It is referred to *Hemanthias vivanus* pending a revision of the genus.

2. *Alectis crinitus* (Mitchill). African pompano. Although juveniles of this species are occasionally reported from the northern Gulf of Mexico (Springer and Hoese, 1958; Richmond, 1968), adults appear to be very rare. A large (615 mm SL, 10 pounds) male was taken on hook and line (squid bait on snapper rig) by charter boat captain Charlie Sebastian in late August, 1970. The specimen comes from Block 130 south of Timbalier Island, about 40 miles south of Grand Isle, in about 185 feet of water. It appears to be the first published Louisiana record, and the first adult recorded from the northern Gulf, excluding Florida. Measurements: greatest depth, 270; head length, 171; eye, 33; pectoral, 184; longest anal ray, 249 mm. The dorsal fin was still filamentous, with at least one ray (others broken) extending beyond the caudal fin; filaments were banded with black and white much as in juveniles. Black blotches were present at the upper edge of the operculum, above the eye, and on the dorsal half of the caudal peduncle. The testes were large, unequal (right 82, left 70 mm long), and firmly connected to the gut by tough membrane; surfaces were rough, like shagreen. Stomach contents consisted of five large (90 mm total length) mantis shrimp, *Squilla empusa*. All were doubled-up, with the bend pointed posteriorly; three specimens were quite fresh in appearance. The stomach, liver, and pyloric caeca were covered by a partially transparent, tough, and adherent membrane; peritoneum white.

3. *Kyphosus sectatrix* (Linnaeus). Bermuda chub. This mostly tropical and Gulf Stream species is reported by SCUBA divers to occur in large schools near oil rigs in clear water south of Grand Isle. The only available specimen, 265 mm SL, was speared 16 Aug. 1960, south of Grand Isle. Dawson (1963) reported one specimen from off Cat Island, Mississippi, but the present specimen apparently represents the first Louisiana record.

4. *Holacanthus bermudensis* Goode. Blue angelfish. This species

is also reported to be common near oil rigs in clear water. The available specimen measures 188 mm SL, with an indistinct nape spot and a dark caudal fin with a light terminal band. It was speared 16 Aug. 1960, south of Grand Isle, and represents the first Louisiana record.

5. *Nomeus gronowi* (Gmelin). Man-of-war fish. This pelagic fish is seldom recorded inshore along the Gulf coast, and only three small specimens are available. One specimen, 17.9 mm SL, was taken on 16 April 1961, near the Freeport Sulphur Rig, 4 miles south of Grand Isle. Two additional juveniles, 22.1 and 18.8 mm SL, were dipnetted in the boat basin at Grand Terre I. on 7 Dec. 1961. All three specimens had three brown body saddles, one saddle on caudal peduncle, and long black pelvics connected to the body by a membrane.

6. *Erotelis smaragdus* (Valenciennes). Emerald sleeper. Dawson (1969) reported only two records of this goby in Mississippi and indicated that it is rarely collected. Four Louisiana specimens are in the collection, three from within Barataria Bay. Two juveniles (48.3 and 45.4 mm SL) were taken at Middle Bank Light in April, 1969, and another juvenile (47.8 mm SL) was collected near Independence Island, 20 Jan. 1971. In life this specimen was gray-brown with numerous small dark spots on the sides; dorsal and anal fins were streaked with brown, and the caudal fin was uniformly dark brown. The single large specimen, 103 mm SL, was taken 25 miles south of Grand Isle in May, 1961. These specimens seem to be the first recorded from Louisiana.

LITERATURE CITED

DAWSON, C. E. 1963. *Kyphosus sectatrix* in the Gulf of Mexico with a new record from Mississippi. Copeia, no. 1, pp. 181-182.

———. 1969. Studies on the gobies of Mississippi Sound and adjacent waters II. An illustrated key to Gobioid fishes. Publ. Gulf Coast Res. Lab. Mus., no. 1, pp. 1-59.

GINSBURG, ISAAC. 1952. Eight new fishes from the Gulf Coast of the United States, with two new genera and notes on geographic distribution. J. Wash. Acad. Sci., vol. 42, no. 3, pp. 84-101.

JORDAN, DAVID STARR, AND BARTON W. EVERMANN. 1896. The Fishes of North and Middle America. . . . Bull. U. S. Nat. Mus., vol. 47, part 1, pp. i-lviii, 1-1240.

LONGLEY, WILLIAM H., AND SAMUEL F. HILDEBRAND. 1940. New genera and

species of fishes from Tortugas, Florida. Carnegie Inst. Wash., Papers Tort. Lab., vol. 32, no. 14, pp. 223-285.

———. 1941. Systematic catalogue of the fishes of Tortugas, Florida with observations on color, habits, and local distribution. *Ibid.*, vol. 34, pp. i-xiii, 1-331.

RICHMOND, E. AVERY. 1968. A supplement to the fauna and flora of Horn Island, Mississippi. Gulf Res. Rpts., vol. 2, no. 3, pp. 213-254.

SPRINGER, VICTOR G., AND HINTON D. HOESE. 1958. Notes and records of marine fishes from the Texas coast. Texas J. Sci., vol. 10, no. 3, pp. 343-348.

P. O. Box 49, Hightstown, New Jersey 08520.

Quart. Jour. Florida Acad. Sci. 35(2) 1972(1973)

Antarctica, Isostacy, and the Origin of Frogs

COLEMAN J. GOIN AND OLIVE B. GOIN

IT is a basic tenet of zoogeography that an animal group arises in and spreads from a single area, its center of origin. For larger, more inclusive groups, as the more primitive members move out from the center of origin, successively more advanced forms evolve in the center. As they in turn spread, they tend to eliminate the more primitive forms by competition. A large group that has been in existence for a long time typically shows a pattern of distribution in which the primitive species are located at the periphery of the range, in areas that the more advanced members have not yet reached or have reached only recently.

The more primitive members of many vertebrate groups are found in the southern continents, in South America, Africa south of the Sahara, and Australia. The order Testudinata (turtles) comprises two suborders. The more primitive suborder, Pleurodira, includes the side-necked turtles, which draw the head under the shell by bending the neck to the side. Of the two families of side-necked turtles, Pelomedusidae occur in South America and Africa and Chelidae in South America and Australia. Fossil pelomedusids are known from the Upper Cretaceous of North America and Europe. The suborder Cryptodira includes more advanced forms, which withdraw the head by bending the neck in a sigmoid curve. They are widely distributed in the warmer parts of the northern continents. The only cryptodires to reach Australia are the marine turtles, and cryptodires have probably been in South America and Africa only since the Miocene.

Distribution patterns similar to that shown by the turtles are found in many vertebrates. This led Matthew (1915) to postulate a Holarctic center of origin for the majority of the groups of vertebrates. Darlington, on the other hand, believes that most of the groups arose in the Old World tropics.

Some vertebrates do not conform to the distribution pattern described above and do not seem to have originated either in the Holarctic or in the Old World tropics. One such group is the frogs

(Salientia). We believe that the evidence suggests an Antarctic origin for this group.

ANTARCTICA

This continent, which caps the southern polar region and is covered with ice, seems an improbable place to seek for the origin of frogs, but certainly it was not always as it is today. Although no petroleum or gas have yet been located there, "estimates of enormous coal reserves in the Beacon sediments of the Trans-Antarctic Mountains have been made from time to time" (Warren, 1965, p. 314). The climatic conditions under which coal is formed are also capable of supporting an amphibian fauna. The Beacon Group sediments lie on a peneplain of igneus and metamorphic rocks complex and variable in both age and lithology. In the McMurdo Sound District, the sediments are estimated to range in total age from pre-Devonian to Jurassic. The formation containing *Glossopteris* (Permian) is about 700 m thick in the upper Beardmore district, a thickness unequaled in other areas so far measured. Glacial conditions were present in the late Paleozoic and also in the Jurassic.

Among fossils previously reported from the Beacon Group are Devonian freshwater fishes (Woodward, 1921) and Jurassic freshwater gastropods, fishes, and beetles (Adie, 1962). Plumstead (1964) has given a review of the plant fossils of the Beacon Group. The first amphibian material known from Antarctica is a fragment of a labyrinthodont jaw taken at Graphite Peak in the Trans-Antarctic Mountains by Peter Barrett in 1967. In 1969 Dr. E. H. Colbert and his party collected about 450 specimens of fossil vertebrate material from exposed outcrops in Coalsack Bluff just a few miles from their Beardmore Camp. Additional materials were collected during a second field season. These fossils represent in essence the *Lystrosaurus* fauna.

ISOSTACY

Seismic and gravitational studies (Bentley, 1965; Gow, 1965) indicate that the ice cover over wide-spread areas of Antarctica ranges between 2000-3000 m in thickness; in west-central East Antarctica the land is under a load of 3600 m of ice. Isostatic studies indicate that with this load part of the continent should be depressed about 1000 m.

Antarctica is at present connected with each of the three southern continents, South America, Africa, and Australia, by the following undersea ridges at depths appreciably less than 1000 m: the Scotia Ridge to South America; the Macquarie Rise to Australia; and the Atlantic-Indian Rise, the West Indian Ridge, and the South Madagascar Ridge to Africa. Of these, the Scotia Ridge appears at the surface as the Falkland Islands, South Georgia Island, the South Sandwich Islands, and the South Orkney Islands. The Macquarie Rise reaches the surface as MacQuarie Island and, on the prong that extends to New Zealand, as the Aukland Islands. The Ridge to Madagascar and South Africa appears at the surface as the Bouvet and Prince Edward Islands. These ridges are shown in Figure 1.

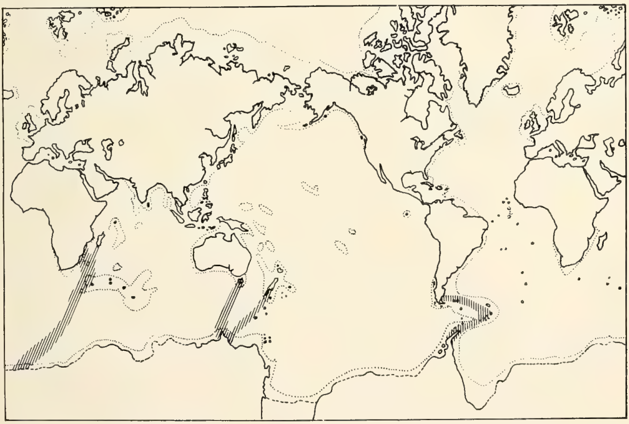


Fig. 1. Present location of undersea ridges that might, at a time of isostatic adjustment, have been emergent ridges or at least island chains that frogs would have been able to cross.

There is no assurance that even if the main body of the continent did rise 1000 m to attain isostatic balance during glacier-free times its margins and the ridges would have risen an equal amount. However, had they been elevated by only one third that amount there could have been either direct land connections or island chains be-

tween Antarctica and the southern continents since the crests of the ridges rise in many places closer than this to the surface.

ORIGIN OF THE FROGS

The earliest known remains of any salientian-type animal are some footprints found in the Ecca formation in the basal Permian of South Africa. The prints are of the fore-feet and indicate the presence of an animal that swam about or groveled on the bottom. The earliest fossilized skeleton is that of *Triadobatrachus* (*Protobatrachus*) from the Lower Triassic of Madagascar. This animal

Fig. 2. Distribution of the three earliest evidences of salientians. "P" are footprints from Permian Ecca beds of South Africa; "T" represents *Triadobatrachus* from the Triassic of Madagascar; "J" is *Vieraella* from the Lower Jurassic of Patagonia. This figure and all of the following distribution maps are based on an Azimuthal Equidistant Projection, centered on the South Pole.

had a froglike skull and showed a tendency toward elongation of the hind legs. These remains indicate that the probable ancestors of the modern frogs were present in Gondwanaland.

The oldest known real frog (order Anura) is *Vieraella* from Patagonia, which shows that the basic anuran pattern had been established by the Lower Jurassic. *Notobatrachus* is from the mid-Jurassic of Patagonia. Upper Jurassic frogs are known from both North America and Europe. Figure 2 shows the distribution of the earliest salientian fossils.

DISTRIBUTION OF MODERN FROGS

The modern families of frogs are divisible into four primitive

Fig. 3. Distribution of the living members of the family Ascaphidae; *Ascaphus* in the northwestern United States and *Leiolopelma* in New Zealand.

families (Ascaphidae, Discoglossidae, Rhinophrynidae, and Pipidae); one family, Pelobatidae that "unquestionably couples the more primitive with the advanced families but, none the less, is separable from both" (Griffiths, 1963, p. 271); and the more advanced families like the Hylidae, Bufonidae, Leptodactylidae, and Ranidae.

Ascaphidae. This most primitive family of living frogs is found today in two widely separated populations: *Leiopelma* in the fog-dampened ridges of New Zealand, and *Ascaphus* in the cold mountain streams of western North America (Fig. 3).

Discoglossidae. Today represented by four living genera, this family shows a typical relict distribution: *Bombina* in Europe and eastern Asia; *Discoglossus* in Europe and northern Africa; *Alytes*

Fig. 4. Distribution of the living members of the family Discoglossidae.

in western Europe; and *Barbourula* on a single island in the Philippines (Fig. 4).

Rhinophrynidae. This family is known from a single species, *Rhinophrynus dorsalis* from the lowlands of Mexico.

Pipidae. This family of highly aquatic frogs comprises one genus from the northeastern coast of South America and three from Africa in a trans-continental belt south of the Sahara but not including southern Africa or Madagascar (Fig. 5).

Pelobatidae. The following three subfamilies of pelobatids are recognized: Pelobatinae, which includes one genus in Europe and northern Africa and another in North America; Pelodytinae (sometimes recognized as a separate family) with a single genus in Eu-

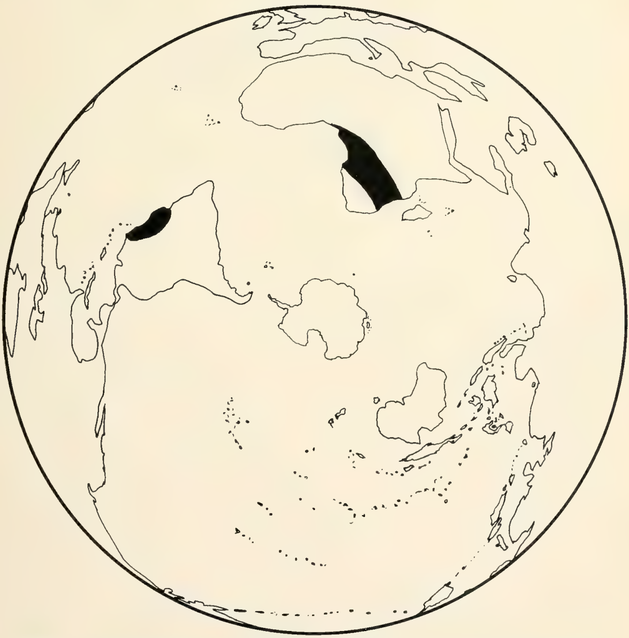


Fig. 5. Distribution of the living members of the family Pipidae.

rope; and Megophryninae with about half a dozen genera and many species in southeastern Asia and the East Indies (Fig. 6).

Ranidae. This is a large, modern family containing many genera and hundreds of species. It is centered in Africa, where six of the seven subfamilies occur; four of them are found no place else. One subfamily is confined to the Seychelles Islands north of Madagascar. Another extends from Africa across southern Asia to the northern coast of Australia. The subfamily Raninae includes several genera of local distribution in Africa and southern Asia and the cosmopolitan genus *Rana* which has spread from Africa through Europe, Asia, and North America and has reached the northern parts of Australia and South America. Figure 7 shows the distribution of the Ranidae except for *Rana*.

Fig. 6. Distribution of the living members of the family Pelobatidae.

Dendrobatidae. This family of three genera and about sixty species is confined to Central America and South America. It is sometimes classed as a subfamily of the Ranidae.

Rhacophoridae. This family of largely arboreal frogs is obviously derived directly from the ranids. At present it is found in Africa, southern Asia, Japan, the Philippines, the East Indies, and Madagascar. There are over a dozen genera and many species.

Microhylidae. This family is found in Africa south of the Sahara, Madagascar, southern Asia and the East Indies to New Guinea and the northern tip of Australia, and in South America. One genus ranges north to central United States and one Asian group north to Manchuria. There are about forty genera and many species. Figure 8 shows the distribution of the Microhylidae.

Fig. 7. Distribution of the living members of the family Ranidae (except *Rana*).

Phrynomeridae. This small family is confined to Africa south of the Sahara. It contains only a single genus and about half a dozen species. As the rhacophorids evolved from a ranid stock, so the phrynomerids apparently evolved from a microhylid stock.

Bufonidae. Except for the cosmopolitan genus *Bufo*, the Bufonidae are found in Africa south of the Sahara (but not Madagascar), southern Asia and the East Indies, and South America (Fig. 9). *Bufo*, with its many species, occurs on most of the major land areas of the world except Australia, New Guinea, and New Zealand.

Atelopodidae. These toads are widespread in Central and South America in the form of *Atelopus*, but the only other genus, *Brachycephalus*, is found only in eastern Brazil.

Hylidae. This large family of tree frogs includes over thirty

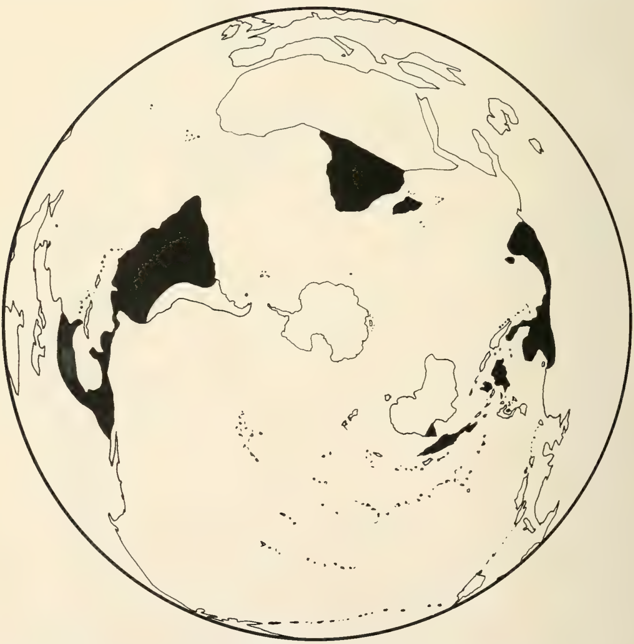


Fig. 8. Distribution of the living members of the family Microhylidae.

genera and several hundred species. Except for the genus *Hyla sensu lato,* and *Nyctimystes* of New Guinea, it is confined to the Americas from northern Argentina northward to extreme southwestern United States (Fig. 10). For the purposes of this paper, we consider the weakly defined North American genera *Pseudacris* and *Acris* to represent simply small groups of semi-specialized *Hyla.* We are not the first to so consider them (Noble, 1931). *Hyla* is widespread not only in South America but also in North America and Australia. A single variable species extends across the Palearctic Region from western Europe and North Africa to Japan.

Leptodactylidae. This is another large family with hundreds of species. The geographic range covers South and Central America

Fig. 9. Distribution of the living members of the family Bufonidae (except *Bufo*).

northward to extreme southwestern United States and Australia and New Guinea. *Heleophryne,* a little-known genus that occurs in the mountains of southern Africa, is sometimes placed in this family, but this allocation is doubted by some herpetologists. Figure 11 shows the distribution of the Leptodactylidae.

Ceratophryidae. This family includes seven genera of wide-mouthed, toadlike forms. It seems to have been derived from the Leptodactylidae and is confined to South America.

Pseudidae. Two small genera of aquatic South American frogs are placed in this family. Its relationships are obscure, but it may have been derived from the Leptodactylidae.

Centrolenidae. This small family of arboreal frogs, which we

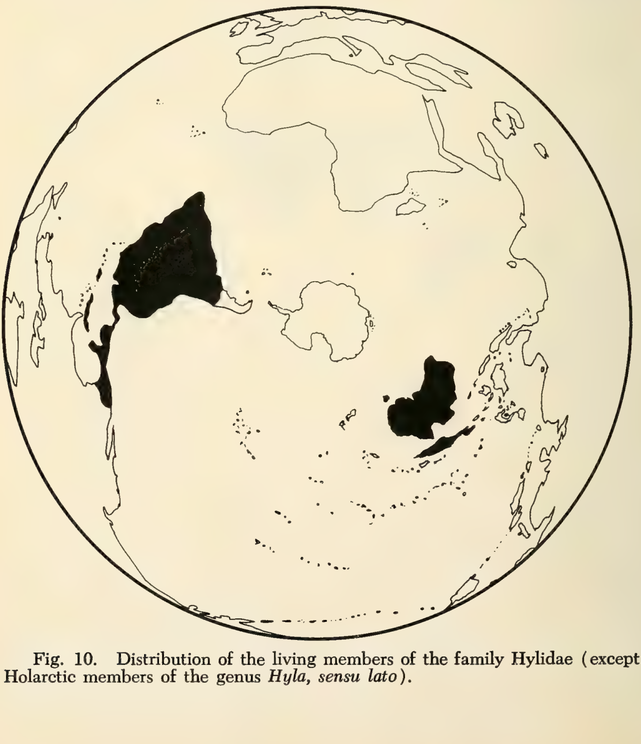


Fig. 10. Distribution of the living members of the family Hylidae (except Holarctic members of the genus *Hyla, sensu lato*).

believe to have been derived from the leptodactylids in South America, occurs only in tropical America.

DISCUSSION

As we look at the data given above, several points stand out. The oldest evidences of any frogs or froglike creatures are geographically close to Antarctica; Permian footprints in the Ecca beds of South Africa, *Triadobatrachus* from the Lower Triassic of Madagascar, and *Vieraella* from the Lower Jurassic of Patagonia.

Primitive living frogs have typical relict distributions with the Ascaphidae in western North America and New Zealand, and the Discoglossidae in Europe, North Africa, eastern Asia and the Philip-

Fig. 11. Distribution of the living members of the family Leptodactylidae.

pines. Except for the oceanic island of New Zealand, all of these geographic points are peripheral when plotted on an Azimuthal Equidistant Projection centered on the South Pole. *Leiopelma* is the only frog on New Zealand and there is no evidence that any other frogs ever reached there. The Pelobatidae also have a disjunct distribution in North America, Europe, and Southeast Asia and the East Indies. Except for *Leiopelma*, the only primitive frogs found in the southern land masses are the completely aquatic Pipidae. Their habits may have sheltered them from competition with the more advanced, more terrestrial forms. They are peripheral ecologically.

Four of the big, modern families of frogs are centered in the southern continents and have spread northward from them. The Hylidae are most numerous in South America; several genera reach extreme southern United States and the genus *Hyla* has spread across much of North America and from there to the Palearctic Region. *Hyla* is common in Australia and New Guinea where it has given rise to the genus *Nyctimystes*. The Leptodactylidae are also very common and diversified in South America and Australia. They have spread northward to southern United States and to New Guinea. If the isolated genus, *Heleophryne*, of the mountains of southern Africa does belong to this family, it may have reached that continent by rafting. The Ranidae have spread from Africa to southern Asia, the East Indies, and northern Australia, and, in the form of *Rana*, to most parts of the world except the central and southern half of Australia and the southern half of South America. The Bufonidae are well represented in Africa and like the ranids seem to have spread from there to southern Asia and the East Indies. *Bufo* has extended its range throughout much of the Palearctic. On the basis of karyological data, the North American members of the genus *Bufo* seem to be allied to the Palearctic forms and were probably derived from them. The South American bufos apparently represent a separate stock.

The microhylids are most numerous in Southeast Asia, Madagascar, and New Guinea. They are present in the northern tip of Australia and in southern Africa. In the New World they extend from Argentina north to central United States. The American microhylids are apparently more closely related to the Southeast Asian forms than to the African ones. Parker (1934) believes the group

originated in Southeast Asia from a pro-ranid stock sometime before the close of the Mesozoic and spread from there southwestward to Africa and Madagascar, southward to New Guinea and Australia, and eastward to the Americas. He suggested that the scarcity of microhylids in Australia in contrast to their great abundance in New Guinea may result from their relatively recent arrival across the Torres Strait but that it more probably reflects the difference in climatic conditions between the two regions. If the latter alternative is correct, the microhylids may once have been more widespread in Australia when the climate was more humid and the direction of spread may have been northward to New Guinea and Southeast Asia.

Except for the relict populations of *Ascaphus*, the discoglossids, and the pelobatids, there is hardly a frog in the Holarctic Region that is not a member of one of three vigorous genera, *Hyla, Rana,* and *Bufo*.

It should also be noted that the large families that are centered in more than one of the southern continents are not necessarily centered in adjacent continents. The bufonids are in Africa and South America but the leptodactylids and hylids are in Australia and South America.

Finally, there are several obviously derived families that should be mentioned. The Rhacophoridae now exist in two separate populations, one in Africa and one in southern Asia. This distribution can be explained in one of two ways. Either the rhacophorids evolved in Africa from the ranids and accompanied them eastward into southern Asia and the East Indies; or, as Laurent (1951) thinks more likely, after the ranids had extended eastward and split into two disjunct populations, each separate stock independently gave rise to arboreal forms. The Rhacophoridae would then be diphyletic in origin. The Phrynomeridae stand in the same relation to the Microhylidae that the Rhacophoridae do to the Ranidae. They (the phrynomerids) are simply microhylids that are modified for climbing. They apparently evolved in and are still restricted to Africa.

Other small families also probably evolved in the place where they live today. We suspect that the Centrolenidae evolved from the Leptodactylidae in South America much as the phrynomerids did from the microhylids in Africa, and that the Atelopodidae arose from the South American Bufonidae. On the other hand, if the

Dendrobatidae are derived from the Ranidae, the ancestors of the family probably arrived in South America from West Africa by rafting. They are more similar to some of the African forms than they are to *Rana,* and *Rana* itself apparently reached South America too recently to have given rise to the distinctive dendrobatids.

Conclusions

The lines of dispersal of the major anuran stocks thus seem to point back to an Antarctic center of origin for the group. The fossil history of the frogs is not well enough documented to allow us to say much about early events in the evolutionary history of the group. If *Triadobatrachus* (order Proanura) of the very early Triassic is on or close to the line leading to the frogs, the salientian stock may have originated in the late Paleozoic. It is probable that the frogs (order Anura) evolved from the Proanura in the Triassic and that by Late Triassic or Early Jurassic times the radiation of the frogs was under way. The best known of the Upper Jurassic and Cretaceous frogs of the Holarctic Region are placed in the primitive families Discoglossidae and Pipidae, but some fragmentary remains indicate that representatives of the more advanced families were present in the northern hemisphere in the Cretacous and possibly in the Upper Jurassic.

We appeal to isostacy as an explanation for the routes by which the modern frogs spread from Antarctica rather than to continental drift because of the more or less random distribution of the major families. The Leptodactylidae and Hylidae are centered in South America and Australia, the Bufonidae in South America and Africa, the Microhylidae possibly in all three, and the Ranidae basically only in Africa. Thus while the frog families were evolving and moving out from Antarctica, this continent was from time to time variously connected with the three southern continents; with Africa but not South America and Australia, with Africa and South America but not Australia, with Australia and South America but not Africa, and also perhaps with all three at the same time. If the radiation of the frogs had taken place before the fragmentation of Gondwanaland, then it seems to us the major families should be equally distributed on all three of the southern continents. On the other hand, if continental drift began shortly before the radiation of the frogs, there was probably a closer isostatic relationship be-

tween Antarctica and the southern continents at that time than there is today.

It is to be hoped that the discovery of additional fossil material in Antarctica and the southern continents will not only elucidate the early history of the frogs but will also contribute to an understanding of the geologic history of Antarctica.

LITERATURE CITED

ADIE, R. J. 1962. The Geology of Antarctica. Geophys. Monogr., vol. 7, pp. 26-39.

BENTLEY, C. R. 1965. The land beneath the ice. *In* T. Hatherton, editor, Antarctica. New York, Frederick A. Praeger, pp. 259-277.

DARLINGTON, P. J. JR. 1957. Zoogeography. New York, John Wiley and Sons, 675 p.

GOW, A. J. 1965. The ice sheet. *In* T. Hatherton, editor, Antarctica. New York, Frederick A. Praeger, pp. 221-258.

GRIFFITHS, I. 1963. The phylogeny of the Salientia. Biol. Rev., vol. 38, pp. 241-292.

LAURENT, R. 1951. Sur la nécessité de supprimer la famille de Rhacophoridae mais de créer celle des Hyperolidae. Rev. Zool. Bot. Afr., vol. 45, pp. 116-122.

MATTHEW, W. D. 1915. Climate and evolution. Ann. New York Acad. Sci., vol. 24, pp. 171-318 (reprinted, 1939, as Special Pub. New York Acad. Sci., 1).

NOBLE, G. K. 1931. Biology of the Amphibia. New York, McGraw-Hill, 577 p. (reprinted, 1954, by Dover Publications).

PARKER, H. W. 1934. A monograph of the frogs of the family Microhylidae. London, British Museum (Natural History), 208 p.

PLUMSTEAD, E. P. 1964. Paleobotany of Antarctica. *In* R. J. Adie, editor, Antarctica geology. Amsterdam, North-Holland Publishing Co., pp. 637-654.

WARREN, G. 1965. Geology of Antarctica, *In* T. Hatherton, editor, Antarctica. New York, Frederick A. Praeger, pp. 279-320.

WOODWARD, A. S. 1921. Fish-remains from the Upper Old Red Sandstone of Granite Harbour, Antarctica. British Antarctica ("Terra Nova") expedition, 1910. Natural history report. Geology, vol. 1, no. 2, pp. 51-62, pl.

Museum of Northern Arizona, P. O. Box 1389, Flagstaff, Arizona 86001.

Quart. Jour. Florida Acad. Sci. 35(2) 1972(1973)

Characteristics of the Western Atlantic Reef-fish Fauna

CARTER R. GILBERT

THE western Atlantic reef-fish fauna is better known than that of any similar area of the world, with the possible exception of the Hawaiian Islands. This should give one an idea of how extremely limited is our knowledge of the faunistically richer and geographically more vast Indo-Pacific region. Most of our knowledge of western Atlantic reef fishes has accumulated during the past 15 years, and this can be attributed to three factors 1) the tremendous increase in numbers of ichthyologists investigating the fauna, 2) the development of SCUBA gear and rotenone-based fish toxicants, and 3) the exploratory fishing activities of the U. S. Bureau of Commercial Fisheries. Of the many new species that have been discovered during this time, a high percentage are small, cryptic reef dwellers, particularly of the families Clinidae and Gobiidae. For example, of the 46 clinids (including the Chaenopsidae and Tripterygiidae) and 41 gobies listed by Böhlke and Chaplin (1968) for the Bahamas, 18 species in each family have been described since 1953. In addition, two Bahamian gobies and one clinid have since been named, and at least a dozen other known Bahamian species have yet to be described. Many others undoubtedly remain to be discovered. The same relative totals for the gobies reported by Starck (1968) from Alligator Reef, Florida, are even more illuminating; 14 of the 27 species listed have been described within the same period. Knowledge of most groups of marine invertebrates is even substantially less than for the fishes.

Although it is unlikely that man's activities will result in the wholesale extermination of reef-fish species from extensive geographic areas, such as has occurred for certain freshwater forms, the need for accurate and relatively complete lists from the various parts of the western Atlantic is no less acute. The faunistic studies for Puerto Rico (Evermann and Marsh, 1902), Haiti (Beebe and Tee-Van, 1928), and the Dry Tortugas (Longley and Hildebrand, 1941) all are very valuable contributions; however, many of the small reef dwellers were not collected because of the primitive diving gear and lack of completely effective fish toxicants. Other use-

ful works are those by Cervigón (1966) for Venezuela and by Caldwell (1966) for Jamaica, although both of these suffer somewhat from the paucity of reef collections below the 50 foot level. The paper by Birdsong and Emery (1968), which lists collections made by Birdsong and Walter A. Starck II from the poorly known western Caribbean, is also a valuable contribution. Other important recent collections of fishes, for which published faunal reports have not yet appeared, are from Puerto Rico and the Virgin Islands (J. E. Randall), Grand Cayman Island (J. C. Tyler and C. R. Gilbert), Haiti (Tyler, T. Devany, and H. A. Feddern), Old Providence Island (Tyler and Gilbert), British Honduras (D. W. Greenfield), and from various islands in the Lesser Antilles (Tyler and W. N. Eschmeyer). The most complete faunal studies, however, are those by Böhlke and Chaplin (1968) for the Bahamas, and by Starck (1968) for Alligator Reef and vicinity, in the northern Florida Keys. The latter undoubtedly is the most thorough study of a limited reef area done anywhere in the world. These two works, together with the paper by C. R. Robins (in press), have provided much of the information upon which the present paper is based.

Despite the large amount of data that has recently accumulated, it is impossible to determine accurately the distribution patterns for many species of western Atlantic reef fishes. Although basically due to the incomplete geographical coverage of our collections, the difference in abundance of various species, either on a permanent basis or at a particular time, is an important contributing factor. This is especially true of the smaller forms. Lack of consistency in the composition of the coral reef-fish fauna from one time to another is, in fact, the rule rather than the exception. Thus, collections made over a limited period of time will almost invariably miss the bulk of the species. For example, Starck (1968) recorded a total of 517 species of fishes from Alligator Reef, Florida, of which 389 are true members of the reef community; however, the most thorough collections from this area at any one time (i.e., day) probably would not exceed 100 or 125 species. Sometimes rarity of usually common species is the result of introduction of occasional strays into an unfavorable ecological situation. Starck's (1968) list includes at least 12 species that evidently fall into this category, all of which are widespread in the Bahamas. Two of these (the chaetodontids *Centropyge argi* and *Prognathodes aculeatus*) main-

tain permanent populations just north of Miami, where the water is consistently more clear than in the Florida Keys, thus leading Starck to conclude that water turbidity (coming from Florida Bay) is the most important factor preventing the establishment of these and other Bahamian species in the Keys. More often, however, the rarity of a species is not so readily explained. A very important thing to realize is that many, if not most, of the small reef species are annuals. Thus, unfavorable environmental conditions during spawning can result in an abrupt and drastic reduction in abundance from one season to the next, as has been demonstrated by Robins (1958) for the gobiid fish *Gobiosoma macrodon* in the Florida Keys. The opposite, of course, can also happen. Short generation time and cyclic fluctuations in size and composition of the gene pool are very important factors in the evolution of coral-reef species.

The tropical western Atlantic fish fauna (as well as that of the tropical eastern Pacific) was derived from the rich Indo-Pacific fauna, elements of which reached the New World at some time prior to the mid-Cenozoic (Rosenblatt, 1963). There are two possible ways in which this could have happened 1) from the west, across the broad, open eastern Pacific; or, 2) from the east, via the prehistoric Tethys Sea. There is considerable evidence, and general agreement among ichthyologists, that the latter route was by far the more important. The Tethys Sea was once located in the area now occupied by the Mediterranean Sea and the countries of the Middle East. As a result, the faunas of the Indo-Pacific had free access to the New World tropics, and many, though by no means all, Indo-Pacific groups succeeded in reaching there. During Miocene times, however, this connection was broken by uplift of the Tethyan syncline, which effectively isolated the Mediterranean and New World faunas from that of the Indo-Pacific. In late Pliocene the final uplift of Middle America occurred, thus splitting the New World tropical fauna in two. Still later, most of the tropical Mediterranean fauna was exterminated as a result of lowered temperatures resulting from Pleistocene glaciation; undoubtedly some of the New World fauna was similarly affected, but to a much lesser degree (Walters and Robins, 1961). As a result of the above series of events, the faunas of the above four areas (eastern Pacific, western Atlantic, Mediterranean, and Indo-Pacific) became progressively less homogeneous with regard to one another, and each proceeded

to develop its own unique characteristics. Because of the extermination of much of its tropical fish fauna and the complete elimination of its living coral reefs, the Mediterranean, despite its intermediate geographical position, has less in common with the other three areas than they do with each other, at least as far as the reef fishes are concerned. For obvious reasons the faunas of the western Atlantic and eastern Pacific are the most similar, with many closely related geminate species, and in some cases the same species, being present in both areas.

The tropical New-World fish fauna is basically a diluted Indo-Pacific fauna. It is characterized by 1) the absence of a number of Indo-Pacific families, 2) nearly always by fewer genera and species than occur in the same families in the Indo-Pacific, and 3) by the near absence of any endemic families (the only exceptions being the Chaenopsidae [Stephens, 1963] and Dactyloscopidae, and some consider the former only to be a subfamily of the Clinidae). However, several distinctive subgroups apparently evolved largely or entirely in the New World, such as the subfamily Gobiesocinae (family Gobiesocidae) (Briggs, 1955), the subtribe Labrisomini (family Clinidae) (Springer, 1959), and the seven-spined species of Gobiidae (Böhlke and Robins, 1968).

The fish fauna of the tropical western Atlantic is substantially richer than that of either the eastern Pacific or eastern Atlantic, particularly with regard to the rock or reef-inhabiting forms. This can be attributed both to the more compressed tropical zones and near-absence of coral reefs in the latter two areas. The fish fauna of the western Atlantic, however, is not nearly so speciose as that of the Indo-Pacific. Starck (1968, pp. 12-13) has estimated that the fish fauna of Alligator Reef, Florida, contains approximately half as many species as areas of comparable size in the Indo-Pacific. Considering that the Indo-Pacific region also is geographically much more extensive than the western Atlantic, it is likely that at least 3.5 times as many kinds of reef fishes (or approximately 2500 species) occur throughout the former area.

Although the Indo-Pacific as a whole is richer than the western Atlantic, this does not tell the complete story. The difference in numbers of genera and species between some groups is much more pronounced than between others, and in one case (the Clinidae) the situation is completely reversed. A comparison of the number

of genera and species of several typical reef families from the western Atlantic and Marshall Islands (Table 1) illustrates these points (data from latter area from Schultz et al, 1953; 1960).

TABLE 1
Comparison of number of genera and species for some marine fish families

	Western Atlantic	Marshall Islands
Acanthuridae	1-4	4-22
Apogoniidae (shallow-water)	3-21	7-32
Blenniidae	6-15	15-35
Clinidae (including Chaenopsinae and Tripterygiinae)	14-60	2-6
Holocentridae	7-11	5-19
Labridae	7-19	21-55
Pomacentridae	5-15	5-41

Although not included in Table 1, the total number of New-World species of Gobiesocidae is approximately the same as for the Indo-Pacific; however, unlike the clinids, this is not true for the genera, which are about three times as numerous in the Indo-Pacific (Briggs, 1955). The large total number of New-World gobiesocid species is, in great degree, due to the explosive evolution of the subfamily Gobiesocinae (particularly the genus *Gobiesox*) in the eastern Pacific.

The most notable exception to the rule of greater species numbers in the Indo-Pacific is seen in the family Clinidae. A partial explanation for this may be that competition from the closely related blenniids has prevented extensive clinid speciation in the Indo-Pacific, whereas many of the ecological niches occupied by the blennies in the Indo-Pacific are taken over by the clinids in the New World (Starck, 1968, p. 13). Another interesting aspect to this is that only about half the approximately 15 western Atlantic blenniid species are characteristic components of the tropical reef fauna (Böhlke, 1959; Springer, 1962, 1967; Randall, 1966), whereas the others occur in rocky situations outside the limits of living coral reefs. Of these, most reef-inhabiting species belong to the subfamily Salariinae, whereas most non-reef forms are of the subfamily Blenniinae (V. G. Springer, *pers. comm.*). In contrast, no western Atlantic clinid species lives totally out of the reef area. This situation differs somewhat from what one finds in the eastern Pacific,

where five genera of clinids (including 13 species) are entirely restricted to cool waters (*Alloclinus, Cryptotrema, Gibbonsia, Heterostichus,* and *Neoclinus*) (Hubbs, 1952, 1953, 1954).

One of the most noticeable differences between the western Atlantic and Indo-Pacific reef faunas is the relative contributions, in terms of biomass, of certain fish families. This cannot be attributed solely to differences in species numbers, although it may be factor. In the western Atlantic the grunts (Pomadasyidae) and sometimes the snappers (Lutjanidae) may occur in tremendous numbers, a phenomenon one does not usually see in the Indo-Pacific (where the Pomadasyidae is largely replaced by the closely related, or identical, Gaterinidae). In the Indo-Pacific the surgeonfishes (Acanthuridae) and cardinalfishes (Apogonidae), in particular, are much more important, in terms of total weight, than in the western Atlantic.

Although we are primarily concerned with the western Atlantic reef fishes, it is necessary to consider briefly those fishes living in other habitats as well. Robins (1971) recognizes two kinds of tropical fish faunas, Continental and Insular. Continental faunas live in regions where environmental change is the rule (temperature, salinity, and turbidity), whereas Insular faunas occur in regions of great environmental stability. Turbid waters, muddy or silty bottom, and absence of coral reefs are characteristic features of the continental habitat, just as clear water, bottom sediments composed mainly of calcium carbonate, and extensive coral reef development are usual features of the insular habitat.

Certain fish families are primarily continental in distribution, although none (at least of those containing more than a few species) is exclusively so. Typical continental families in the western Atlantic include the Sciaenidae (of which all but six of the over 60 western Atlantic species are continental), Batrachoididae (only one of 24 is insular, and that perhaps not entirely so; Walters and Robins, 1961), Sparidae, Ophidiidae, Bothidae, and Cynoglossidae. Some, such as the Gobiidae, are about equally divided with regard to numbers of continental and insular forms, and others (e.g., the Pomadasyidae) contain mostly insular forms. The family Carangidae in general, as well as certain individual species in other families (the sphyraenid *Sphyraena barracuda,* the gobiids *Bathygobius soporator* and *Gobionellus boleosoma,* the gerreids *Eucinostomus ar-*

genteus and *E. gula*, the blenniid *Blennius cristatus*, the ophichthid *Myrophis punctatus*, and the lutjanids *Lutjanus griseus* and *L. jocu*), seem to be at home in either type of environment. All of these are wide-ranging forms that evidently have an unusual ability to adapt to a wide variety of ecological conditions. Those families essentially limited to continental waters would be expected to have limited mobility, both during larval and adult stages. Although some do (e.g., the Batrachoididae), this is by no means always true. As Robins (1971) points out, one of the most characteristic continental species is the Spanish mackerel (*Scomberomorus maculatus*), and only one of the nine Florida species of the ophichthid eel genera *Ophichthus*, *Bascanichthys*, *Echiopsis*, and *Letharchus* (a deep-water species of *Ophichthus*) occurs in the Bahamas. All of the above are highly pelagic at some stage of their life history, and there is nothing to prevent them from reaching insular areas. This brings up a most important point, which Starck (1968) and Robins (1971) have clearly shown: that the distinctions between the continental and insular faunas are due in much greater degree to ecological barriers than to physical barriers to movement.

The tropical continental fauna may be divided into northern and southern components (Robins, 1971), the former extending from central Florida (or in summer from the Carolinas) southward toward the tip of Florida and around the Gulf of Mexico to Yucatan; the latter extends from Yucatan southward. Exceptions to this occasionally occur; for example, the northern sciaenids *Menticirrhus littoralis* and *M. americanus* have been collected in the Caribbean (Roy D. Irwin, *pers. comm.*), and the southern sciaenid *Bairdiella sanctaeluciae* has recently been taken on the lower east Florida coast (specimens in Unversity of Florida and Cornell University collections). Of the 30 species of Sciaenidae recorded for Venezuela (Cervigón, 1966, pp. 499-539), however, only six occur in Florida (four in the Bahamas); all but one (the above *B. sanctaeluciae*) are clear-water inhabitants (atypical for sciaenids) of the genera *Equetus*, *Odontoscion*, and *Umbrina*, and have insular, rather than continental, distributions. Of the 26 species recorded from Guyana by Lowe (McConnell), 1966, only *B. sanctaeluciae* and the insular *Equetus lanceolatus* also occur in Florida. This distribution even holds at the generic level, inasmuch as only seven of the total of 21 sciaenid genera are common to both the Guianas and Florida. As

might be expected, those families of greater mobility are more likely to have species of wide distribution. Thus, of the six species of the eel family Ophichthidae (not including two species of Echelinae) listed by Cervigón (1966, pp. 186-197) from Venezuela, three (*Echiopsis intertincta, Ophichthus gomesi,* and *Ophichthus ocellatus*) are also elements of the Florida continental fauna.

The insular fauna extends, in pure form, from the Bahamas southward through the West Indies. Because of its area and extent of coral-reef development, the Bahamas may be considered to be the center of the western Atlantic insular fauna. Bermuda and the islands of the Fernando Naronha group (off the eastern hump of Brazil) are distant outposts of this fauna. Varying degrees of mixing of the insular and continental faunas occur in Florida, the Greater Antilles, Trinidad, and along much of the Central and South American coasts. The richness of the Florida Keys fish fauna is due in large degree to this mixing effect (Starck, 1968, p. 10).

In contrast to the continental groups, one finds a number of families in which all species (in the western Atlantic at least) are more-or-less strictly confined to an insular habitat. This includes the Chaetodontidae, Holocentridae, Apogonidae, Clinidae, Scaridae, Labridae, and perhaps the Pomacentridae. For the first two families this is invariably true, as it is for the Labridae (if one does not consider the two northern cold-water genera *Tautoga* and *Tautogolabrus*). However, some of the other families contain representatives which, though found in a basically insular environment, seem to require a certain degree of continental influence. For example, the clinid *Starksia ocellata* is always found in rocks or reefs and is one of the most common of the Florida Clinidae. It is absent from the Bahamas, but occurs in the Greater Antilles and along the Central and South American coasts (Gilbert, 1971). Other examples are the apogonid *Astrapogon alutus* and the scarid *Nicholsina usta,* both of which are absent from the Bahamas and present in Florida, where they are especially common along the west coast.

The insular fauna of the western Atlantic, in contrast to the continental fauna, is characterized by relative homogeneity; and some species, nearly all with long-lived pelagic larvae, have very wide distributions. For example, *Labrisomus nuchipinnis* (Clinidae), *Rypticus saponaceus* (Grammistidae), *Holocentrus ascensionis* and *Myripristis jacobus* (Holocentridae), *Bothus lunatus* (Bothidae),

Acanthostracion quadricornis (Ostraciidae), *Pomacentrus leucostictus* and *Chromis insolatus* (Pomacentridae), *Diodon holacanthus* (Diodontidae), *Epinephelus adscensionis* and *Paranthias furcifer* (Serranidae), *Malacanthus plumieri* (Branchiostegidae), *Scorpaena plumieri* (Scorpaenidae), *Mulloidichthys martinicus* (Mullidae), *Acanthurus bahianus* and *A. coeruleus* (Acanthuridae), *Balistes vetula* and *Melichthys niger* (Balistidae) all range from Florida to Ascension Island and/or St. Helena or beyond (Cadenat and Marchal, 1963). The vast majority of insular species, however, have much more restricted distributions. Florida, for example, has eight apparently endemic reef or reef-associated species (*Hypoplectrus gemma* and *Liopropoma eukrines* [Serranidae], *Lythrypnus phorellus, Gobionellus stigmaturus,* and *Ioglossus calliurus* [Gobiidae], *Starksia starcki* [Clinidae], *Emblemariopsis diaphana* [Clinidae, subfamily Chaenopsinae], and *Ophidion selenops* [Ophidiidae]. In addition, the pomacentrid *Chromis scotti,* though recently discovered in the Bahamas (C. R. Robins, *pers. comm.*), probably should be included in this group. Although some of the above will likely be discovered elsewhere, others probably will not. For example, *Hypoplectrus gemma* is a fairly common, readily-observed species in tropical Florida waters, and it seems unlikely that such a distinctive fish would have been overlooked elsewhere. Other western Atlantic reef species undoubtedly have equally restricted distributions, although collections outside of Florida are not yet complete enough to know just which species are involved, particularly the deeper-living forms. The main point, however, is that there is no clearcut division of the insular fauna into northern and southern components, as there is for the continental fauna. Of the 23 species of Clinidae (including the Chaenopsidae and Tripterygiidae) reported by Cervigón (1966, pp. 660-689) from Venezuela, 14 occur in the Bahamas and 13 in Florida. This contrasts sharply with the very dissimilar sciaenid faunas in these two areas (see above).

The only island in the tropical western north Atlantic that is sufficiently isolated that it could be a significant center of endemism is Bermuda. This island, however, possesses relatively few endemics, only 14 forms (or about five per cent) presently falling into this category, none of which is very strongly differentiated (Collette, 1962; Caldwell, 1965; Briggs, 1966). The fauna is, in fact, on the depauperate side, particularly with regard to the small cryptic reef

species. This problem has been discussed by Briggs (1966), who points out that Bermuda is located sufficiently far north as to have been adversely affected by the cooling effects of the various Pleistocene glaciations. Insufficient time has elapsed since the last (Wisconsin) glacial period to permit recruitment and subsequent evolution of a highly endemic fish fauna.

The only other area in the tropical western Atlantic that would be predicted to harbor a substantial endemic fauna is the coast of extreme eastern Brazil, including the offshore islands of the Fernando Naronha group. This area has living coral reefs, and is over 1000 miles from the next closest area of extensive reef development (i.e., Trinidad) (Böhlke and Chaplin, 1968: inside front cover). Not only is the coastline to the northwest largely devoid of favorable habitat for most reef species, but two major river systems (the Amazon and Orinoco) empty large volumes of turbid, hyposaline water into the intervening ocean. One would expect, as a result of this isolation, for some faunal endemism to have developed, and the few available collections from this area indicate that such is indeed the case.

This is not to say that all insular faunas will be as noticeably homogeneous as that of the western Atlantic. For example, in the eastern Pacific the long, linear open shoreline of the western Middle American coast (punctuated by widely separated rocky outcrops); the absence of fringing coral reefs along shore and the near-absence of closely adjacent offshore islands; the presence of distant offshore islands (Galapagos, Cocos, Clipperton, and the Revillagigedos); cold upwellings at various points along the coast; and the geographical and physical nature of the Gulf of California have resulted in numerous pockets of endemism among the basically insular fish groups. In contrast, the tropical western Atlantic is a circular, semi-enclosed sea, containing numerous closely-adjacent islands; and with rich coral growths present around nearly all the islands and bordering much of the shoreline. In addition, the Gulf Stream flows through the Caribbean Sea, Gulf of Mexico, and up the Florida Straits between the Bahamas and Florida. This current is very important in distributing the pelagic larvae or adults of many kinds of organisms, either directly or as a result of subsidiary "spin-off" currents (Caldwell, 1963).

I have reviewed a number of papers on western Atlantic reef

fishes to see if I could find evidence of specific distribution patterns. The results have not been very conclusive. There is some evidence that distinct patterns do exist, although considerably more work is necessary before these can be accurately delineated. To take one example, the gobiid *Gobiosoma louisae* and the holocentrid *Adioryx poco* have been recorded only from the Bahamas, Grand Cayman Island, and Providencia (Old Providence) Island. This may be due in part to the fact that neither of these species lives in very shallow water; however, it could well be significant that neither has been collected in Puerto Rico or the Virgin Islands, despite extensive deep work by Dr. John E. Randall.

Although living coral reefs in Florida are found only a short distance north of Miami, the ranges of a number of reef-inhabiting fish species extend considerably farther northward. Recent exploratory fishing by the U. S. Bureau of Commercial Fisheries has revealed that apparent resident populations of reef species such as *Holocentrus ascensionis* and *Myripristis jacobus* (Holocentridae), *Chaetodon sedentarius* and *Holacanthus tricolor* (Chaetodontidae), *Anisotremus virginicus* (Pomadasyidae), and *Bodianus pulchellus* (Labridae) occur much farther north (to Cape Hatteras, North Carolina) than was previously realized (Anderson and Gutherz, 1965). These fishes live in rocky outcroppings offshore, where they are restricted to somewhat deeper water than is usual for more tropic latitudes. Their restriction to these deeper waters is occasioned by the cold winter temperatures inshore, coupled with the moderating effects of the Gulf Stream offshore. The scarcity of favorable habitat inshore may also be a partial, though less important, factor. A few of the reef species maintain permanent populations in rocky inshore areas along the Florida coast, at least as far north as Matanzas Inlet (ca. 50 miles south of Jacksonville). The most notable of these is *Labrisomus nuchipinnis* (family Clinidae), a hardy, wide-ranging species that occurs south to eastern Brazil and across the Atlantic to West Africa (Springer, 1959, p. 486). This species is excessively abundant in rocky situations along the Florida coast, much more so than it ever is in coral-reef areas, where it must compete with other closely related species. Other reef species found here include *Starksia ocellata* (Clinidae), *Anisotremus surinamensis* (Pomadasyidae), *Scorpaena plumieri* (Scorpaenidae), and *Abudefduf saxatilis* and *A. taurus* (Pomacentridae)

(Gilbert, 1969). The last four species, however, may not represent permanent populations, but instead may be the result of a more or less continuous recruitment of eggs and young from the south, which are carried north and deposited by the Gulf Stream. In addition, this rocky shoreline is also inhabited by certain other species that either are rare in the tropics or do not occur there at all; *Gobiesox strumosus* (Gobiesocidae), and *Hypleurochilus geminatus* and *Hypsoblennius hentzi* Blenniidae). Similar extensions of the tropical reef fauna are known from the eastern and northern Gulf of Mexico (Briggs, 1958; Caldwell, 1959, 1963; Springer and Woodburn, 1960; Caldwell and Briggs, 1957; Briggs and Caldwell, 1957; Dawson, 1962, 1963), as well as for the western Gulf (Hoese, 1959; Springer and Hoese, 1958; Briggs, Hoese, Hadley, and Jones, 1964). They apparently represent a mixture of both resident and non-resident species, the latter of which are annually recruited from the south but do not survive the cold winter temperatures.

This paper was presented at a symposium on coral-reef biology held at Bimini, Bahamas, in March, 1969, which was partly supported by ONR grant no. 552(07).

LITERATURE CITED

ANDERSON, W. D. JR., AND E. J. GUTHERZ. 1965. New Atlantic coast ranges for fishes. Quart. Jour. Florida Acad. Sci., vol. 27, no. 45, pp. 299-306.

BEEBE, W., AND J. TEE-VAN. 1928. The fishes of Port-au-Prince Bay, Haiti/ with a summary of the known species of marine fish of the island of Haiti and Santo Domingo. Zoologica, vol. 10, no. 1, pp. 1-279.

BIRDSONG, R. S., AND A. R. EMERY. 1968. New records of fishes from the western Caribbean. Quart. Jour. Florida Acad. Sci., vol. 30, no. 3, pp. 187-196.

BÖHLKE, J. E. 1959. A new fish of the genus *Hypsoblennius* (Blenniidae) from the Bahamas. Notulae Naturae, no. 321, pp. 1-5.

BÖHLKE, J. E., AND C. C. G. CHAPLIN. 1968. Fishes of the Bahamas and adjacent tropical waters. Livingston Publ. Co., Wynnewood, Pa., pp. v-xxiii, 1-771.

BÖHLKE, J. E., AND C. R. ROBINS. 1968. Western Atlantic seven-spined gobies, with descriptions of ten new species and a new genus, and comments on Pacific relatives. Proc. Acad. Nat. Sci. Philadelphia, vol. 120, no. 3, pp. 45-174.

BRIGGS, J. C. 1955. A monograph of the clingfishes (Order Xenopterygii). Stanford Ich. Bull., no. 6, pp. ii-iv, 1-224.

———. 1958. A list of Florida fishes and their distribution. Bull. Florida State Mus., Biol. Sci., vol. 2, no. 8, pp. 223-318.

———. 1966. Oceanic islands, endemism, and marine paleo-temperatures. Syst. Zool., vol. 15, no. 2, pp. 153-163.

BRIGGS, J. C., AND D. K. CALDWELL. 1957. *Acanthurus randalli*, a new surgeon fish from the Gulf of Mexico. Bull. Florida State Mus., Biol. Sci., vol. 2, no. 4, pp. 43-51.

BRIGGS, J. C., H. D. HOESE, W. F. HADLEY, AND R. S. JONES. 1964. Twenty-two new marine fish records for the northwestern Gulf of Mexico. Texas Jour. Sci., vol. 16, no. 1, pp. 113-116.

CADENAT, J., AND E. MARCHAL. 1963. Résultats des campagnes océanographiques de la Reine-Pokou aux iles Sainte-Hélène et Ascension. Bull. de l'Inst. Francais d'Afrique Noire, 25, vol. A, no. 4, pp. 1235-1315, figs. 1-48.

CALDWELL, D. K. 1959. Observations on tropical marine fishes from the northeastern Gulf of Mexico. Quart. Jour. Florida Acad. Sci., vol. 22, no. 1, pp. 69-74.

———. 1963. Tropical marine fishes in the Gulf of Mexico. Quart. Jour. Florida Acad. Sci., vol. 26, no. 2, pp. 188-191.

———. 1965. A new sparid fish of the genus *Diplodus* from Bermuda. Fieldiana (Zoology), vol. 44, no. 23, pp. 217-225.

———. 1966. Marine and freshwater fishes of Jamaica. Bull. Inst. Jamaica, Sci. Ser., no. 17, pp. 1-120.

CALDWELL, D. K., AND J. C. BRIGGS. 1957. Some extensions of western North Atlantic fishes with notes on some soles of the genus *Gymnachirus*. Bull. Florida State Mus., Biol. Sci., vol. 2, no. 1, pp. 1-11.

CERVIGÓN, M. F. 1966. Los Peces marinos de Venezuela. Vols. 1-2. Fund. La Salle Cien. Nat. Monogr., nos. 11-12, pp. 1-951.

COLLETTE, B. B. 1962. *Hemiramphus bermudensis*, a new halfbeak from Bermuda, with a survey of endemism in Bermudian shore fishes. Bull. Mar. Sci. Gulf and Caribbean, vol. 12, no. 3, pp. 432-449.

DAWSON, C. E. 1962. New records and notes on fishes from the north-central Gulf of Mexico. Copeia, 1962, no. 2, pp. 442-444.

———. 1963. *Kyphosus sectatrix* (Linnaeus) in the Gulf of Mexico with a new record from Mississippi. Copeia, 1963, no. 1, pp. 181-182.

EVERMANN, B. W., AND M. C. MARSH. 1902. The fishes of Porto Rico. Bull. U. S. Fish Comm. (1900), vol. 20, no. 1, pp. 49-350, 49 col. pls.

GILBERT, C. R. 1968. Western Atlantic batrachoidid fishes of the genus *Porichthys*, including three new species. Bull. Mar. Sci., vol. 18, no. 3, pp. 671-730.

———. 1969. A mass inshore movement of fishes on the Florida coast. Quart. Jour. Florida Acad. Sci., vol. 31, no. 1, pp. 70-78.

———. 1971. Two new Atlantic clinid fishes of the genus *Starksia*. Quart. Jour. Florida Acad. Sci., vol. 33, no. 3, pp. 193-206.

HOESE, H. D. 1959. A partially annotated checklist of the marine fishes of Texas. Publ. Inst. Mar. Sci., vol. 5, pp. 312-352.

HUBBS, C. 1952. A contribution to the classification of the blennioid fishes of the family Clinidae, with a partial revision of the eastern Pacific forms. Stanford Ich. Bull., vol. 4, no. 2, pp. 41-165.

———. 1953. Revision and systematic position of the blenniid fishes of the genus *Neoclinus.* Copeia, 1953, no. 1, pp. 11-23.

———. 1954. Additional records of clinid fishes, with the description of a new species of *Cryptotrema* from the Gulf of California. Copeia, 1954, no. 1, pp. 17-19.

LONGLEY, W. H., AND S. F. HILDEBRAND. 1941. Systematic catalogue of the fishes of Tortugas, Florida, with observations on color, habits, and local distribution. Carnegie Inst. Washington, Publ. no. 535, pp. i-xiii, 1-331, 34 pls.

LOWE (MCCONNELL), R. H. 1966. The sciaenid fishes of British Guiana. Bull. Mar. Sci., vol. 16, no. 1, pp. 20-57.

RANDALL, J. E. 1966. The West Indian blenniid fishes of the genus *Hypleurochilus,* with the description of a new species. Proc. Biol. Soc. Washington, vol. 79, pp. 57-71.

ROBINS, C. R. 1958. *Garmannia zebrella,* a new gobiid fish from Trinidad, with notes on the species of the subgenus *Tigrigobius* Fowler. Jour. Wash. Acad. Sci., 48(6):192-198.

———. 1971. Distributional patterns of fishes from coastal and shelf waters of the tropical western Atlantic. *In* Symposium on investigations and resources of the Caribbean Sea and adjacent regions, pp. 249-255. FAO, Fish. Rep. 71-2.

ROSENBLATT, R. H. 1963. Some aspects of speciation in marine shore fishes. Syst. Assoc. Publ. no. 5 (Speciation in the Sea), pp. 171-180.

SCHULTZ, L. P., E. S. HERALD, E. A. LACHNER, A. D. WELANDER, L. P. WOODS. 1953. Fishes of the Marshall and Marianas Islands. Bull. U. S. Nat. Mus., vol. 202, no. 1, pp. ii-xxxii, 1-685.

SCHULTZ, L. P., W. M. CHAPMAN, E. A. LACHNER, L. P. WOODS. 1960. Fishes of the Marshall and Marianas islands. Bull. U. S. Nat. Mus., vol. 202, no. 2, pp. ii-ix, 1-438.

SPRINGER, V. G. 1959. Systematics and zoogeography of the clinid fishes of the subtribe Labrisomini Hubbs. Publ. Inst. Mar. Sci., vol. 5, pp. 417-492.

———. 1962. A review of the blenniid fishes of the genus *Ophioblennius* Gill. Copeia, 1962, no. 2, pp. 426-433.

———. 1967. Revision of the circumtropical shorefish genus *Entomacrodus* (Blenniidae: Salariinae). Proc. U. S. Nat. Mus., vol. 122, no. 3582, pp. 1-150, pls. 1-30.

SPRINGER, V. G., AND H. D. HOESE. 1958. Notes and records of marine fishes from the Texas coast. Texas Jour. Sci., vol. 10, no. 3, pp. 343-348.

SPRINGER, V. G., AND K. D. WOODBURN. 1960. An ecological study of the fishes of the Tampa Bay area. Florida State Bd. Conservation, Prof. Papers Ser., no. 1, pp. i-v, 1-104.

STARCK, W. A. II. 1968. A list of fishes of Alligator Reef, Florida, with comments on the nature of the Florida reef fish fauna. Undersea Biology, vol. 1, no. 1, pp. 1-40.

STEPHENS, J. S., JR. 1963. A revised classification of the blennioid fishes of

the American family Chaenopsidae. Univ. California Publ. Zool., no. 68, pp. iii-iv, 1-165.

WALTERS, V., AND C. R. ROBINS. 1961. A new toadfish (Batrachoididae) considered to be a glacial relict in the West Indies. Amer. Mus. Novitates, no. 2047, pp. 1-24.

Florida State Museum, University of Florida, Gainesville, Florida 32611.

Quart. Jour. Florida Acad. Sci. 35(2) 1972(1973)

Annotated Checklist of the Boynton Beach Hammock

DANIEL F. AUSTIN AND JOANNE G. WEISE

EAST of highway A1A between the Boynton Beach Inlet and the "developed" portion of beach in Boynton Beach, Palm Beach County, Florida, is a strip of land covered by a natural plant association known as "Shore Hammock," "Beach Hammock" (Harper, 1927), or "Coastal Hammock" (Davis, 1943). This half-mile long hammock is unique in that it is the last of its size existing on the eastern peninsular coast of the state and is an extension of this type of vegetation north of the last reported site (Alexander, 1958b). There are scattered remnants of beach hammocks in a few spots along the east coast, but north of the Keys they lack the complexity and undisturbed aspects of the hammock at Boynton Beach. Most of these hammocks have been destroyed and replaced with hotels, motels, and condominiums (Alexander, 1958b). Even in 1927 when Harper wrote his *Natural History of Southern Florida* this vegetation type was considered "very sparingly represented on the east coast."

Since the Boynton Beach Hammock is scheduled to become another accession of the "Florida Gold Coast" syndrome of land "development" in response to malignant population growth, it is imperative that the plant species present be recorded. The site has been used by different members of Florida Atlantic University as an "outdoor laboratory" for several years, and their use will continue until the demise of the hammock. Perhaps before this beach hammock is destroyed, we will be able to record some of the biological complexities that allowed its development and existence. The accompanying checklist is a small contribution to that record.

The vegetation of beach hammocks or, as they are sometimes called, "cactus thickets," is in many ways similar to the deserts of the southwestern United States. Several spiny plants related to desert species occur in the association. Among these spiny plants are *Yucca, Erythrina* (Coral-Bean), *Zanthoxylum* (Wild-lime), *Caesalpinia* (Nicker Bean), *Opuntia* (Prickly-Pear Cactus), *Acanthocereus* (Barbed-Wire Cactus), and *Agave* (Century Plant). Most of these prickly plants are restricted to the ocean side of the hammock at the ecotone between the hammock and the beach.

To the ocean side of the prickly zone is a beach plant association common in subtropical and tropical latitudes throughout the New World (Sauer, 1967). The portion inland from the prickly zone contains the actual hammock. Common trees in the hammock are *Sabal palmetto* (Cabbage Palmetto), *Bursera simaruba* (Gumbo Limbo), *Metopium toxiferum* (Poison Wood), *Coccoloba uvifera* (Sea Grape), *Mastichodendron foetidissimum* (Mastic), and *Ficus aurea* (Wild Fig). The transition from open beach to the center of the hammock involves a vegetational, water, and mineral content gradient. The hammock itself is the most favorable habitat because of higher moisture, more stable temperature, wind protection, and increased mineral content.

The substratum throughout the hammock is composed primarily of sand. This sand is mostly a non-siliceous type derived from the shells of sea bivalves; calcium content is very high. The substratum forms a series of terraces between the hammock and shore which coincide with the height of major tides, and a series of higher dunes beneath the hammock. These dunes are part of old ocean deposits (Cooke, 1939, 1945) which have been stabilized by the hammock vegetation. The special xeric conditions of coastal hammocks make them ecologically unique.

There are several noteworthy floristic differences between this hammock and those described from other areas of Florida. The ocean depth and currents and the prevailing wind patterns account for some of the divergence from the beach hammocks described on the western coast by Harper (1927). Kurz (1942) studied beach areas north of that at Boynton Beach and consequently found heavy influence from the temperate flora. Those hammocks described by Phillips (1940), and Alexander (1958a) are inland hammocks differing in species composition from coastal hammocks.

The herb composition of the Boynton Beach Hammock is similar to the description given by Harper (1927). There are some species in each area which are unique, but this might be expected as a result of dispersal from available floristic sources. The major difference is the complete absence of Bromeliaceae and Orchidaceae at the Boynton Beach Hammock. Harper listed three widely distributed species of air plants, *Tillandsia utriculata, T. balbisiana,* and *T. fasciculata* as well as the orchid, *Encyclia tampensis.* None of these has been found at Boynton Beach.

The hammock at Boynton Beach is not particularly rich in species, with only 98 being found. The most characteristic feature of the area is that these species represent 49 different families. Twenty-six of these families are represented by only one species, and twelve by only two species. The families dominating the hammock in terms of numbers of species are, in order of decreasing size, Leguminosae, Gramineae, Euphorbiaceae, Compositae, Rubiaceae, and Convolvulaceae. Each of these families is represented by more than three species.

A common problem with plant nomenclature in southern Florida is that much of it is based on the system used by Small (1933). Many of the problems of synonymy have been solved recently by Liogier (1963, 1965a, 1965b, 1968), Lakela and Craighead (1965), D'Arcy (1967), Radford, Ahles, and Bell (1968), Ward (1968), and Long (1970). Where pertinent the names used, with a few exceptions, follow these authors. When exceptions occur, they are usually followed by the synonym used by these authors, who are abbreviated with the first letter of their surnames, and the source. For example, *Catharanthus roseus* (= *Vinca rosea* RAB, 1968: 847). Names for the Anacardiaceae follow Gillis (1972); for the Euphorbiaceae they follow Burch (personal communication). Names for the Convolvulaceae follow the interpretation of the senior author.

The family sequence follows Dalla Torre and Harms (1900-1907). Species are listed alphabetically under the appropriate family.

PTERIDOPHYTA

Family Polypodiaceae

Acrostichum aureum L. One population on the lee side of the inner dune near the SW corner. *Austin 4414*.

Phlebodium aureum (L.) J. Sm. A rare epiphyte in the hammock; on *Sabal* in the northern end. *Austin 4419*.

SPERMATOPHYTA

Family Typhaceae

Typha domingensis Pers. A small population found in a depression at the SW corner of the hammock. *Austin 4409*.

Family Gramineae

Cenchrus tribuloides L. Common on the southern end in disturbed areas. *Austin 4396*.

Cenchrus echinatus L. Plants are scattered along the beach, being more or less concentrated in the *Uniola* zone. *Austin 4437*.

Paspalum vaginatum Swartz. Common near the bathing beach. *Weise 1, 2*; det. by O. Lakela.

Pennisetum aff. *latifolium* Spreng. Forming a large clump in a pool near the southern end; apparently an escaped cultivar variety. *Austin 4397*; det. D. B. Ward.

Phragmites communis Trin. One population near the road in a depression at the SW corner of the hammock. *Austin 4411.*

Spartina cynosuroides (L.) Roth? Mostly near the northern end. *Weise 78.*

Stenotaphrum secundatum (Walt.) Kuntze (St. Augustine Grass). Commonly planted as a lawn grass.

Uniola paniculata L. Forming a distinct zone between the lower beach zone (*Ipomoea pes-caprae* zone) and the outer edge of the *Coccoloba* zone. *Weise 12.*

Family Cyperaceae

Cladium jamaicense Crantz (=*Mariscus jamaicensis* RAB, 1968: 214). Found in only one isolated depression near the southern end of the hammock. Not in Lakela and Craighead (1965). *Austin 4415.*

Cyperus thyrsiflorus Schlect. & Cham. Uncommon and scattered around the margins of the hammock. *Austin 4403*; det. J. Beckner.

Remirea maritima Aubl. Common on the middle beach. *Weise 124.*

Family Palmae

Cocos nucifera L. Scattered plants are found near the highway. *Austin 4408.*

Sabal palmetto (Walt.) Lodd. ex Schult. & Schult. Fairly common on inner dune. *Austin 4418.*

Serenoa repens (Bartr.) Small. Fairly common near the bottom at the lee side of the inner dune. *Weise 11.*

Family Lemnaceae

Lemna valdiviana Phil. Floating on water in a small standing pool at the SW corner of the hammock. *Austin 4410.*

Family Commelinaceae

Commelina communis L. Rare. One plant found in a "blow-out." A widely spread weed. *Austin 4392.*

Family Liliaceae

Smilax bona-nox L. Fairly common and scattered throughout the hammock. *Weise 36*; *Austin 4405.*

Yucca aloifolia L. Scattered along the ecotone between the *Uniola* and *Coccoloba* zones. *Carrow* & *Marsh s.n.*

Family Amaryllidaceae

Agave decipiens Baker. Not common. Scattered throughout the "prickly zone." *Weise 77.*

Hymenocallis latifolia (Mill.) Roem. (=*H. keyensis* LC 1965: 26). One patch near the northern end. *Weise s.n.* (4.28.1969).

Family Casuarinaceae

Casuarina equisetifolia Forst. A few plants, mostly near some which are planted by a house at the northern end of the hammock. Introduced. *Austin 4379.*

Family Salicaceae

Salix caroliniana Michx. Several small trees occur near the road close to the center of the hammock. *Austin 4412.*

Family Moraceae

Ficus aurea Nutt. Common along the inner dune. *Weise 85.*

Family Polygonaceae

Coccoloba diversifolia Jacq. Rare, found only on the inner part of the hammock. *Weise 55; Austin 4421.*

Coccoloba uvifera (L.) L. Very common and forming pure stands in a zone between the beach and the hammock. *Weise 28.*

Family Amaranthaceae

Alternanthera maritima (Mart.) St. Hil. Common on the outer edge of the *Coccoloba* zone. *Weise s.n.* (4.24.69).

Iresine celosia L. Uncommon and scattered along the ocean side of the hammock. *Austin 4404.*

Family Batidaceae

Batis maritima L. Fairly common along the beach. Not in Lakela and Craighead (1965). *Weise s.n.* (4.24.69).

Family Phytolaccaeae

Rivina humilis L. Uncommon on the lee side of the hammock. *Weise s.n.* (4.28.69).

Family Aizoaceae

Sesuvium portulacastrum L. Common on the beach. Not in Lakela and Craighead (1965). *Weise 24.*

Family Annonaceae

Annona glabra L. One tree found just north of the depression pool in the SW corner of the hammock. *Austin 4417.*

Family Lauraceae

Cassytha filiformis L. Locally abundant along the ocean side of the hammock. Parasitic on diverse hosts in many different habitats. *Austin 4377.*

Nectandra coriacea (Sw.) Griseb. Fairly common on the lee side of the inner dune. *Weise 65.*

Family Capparidaceae

Capparis cynophallophora L. Fairly common within the hammock. More common on the lee side of the inner dune. *Weise 50.*

Capparis flexuosa (L.) L. Fairly common within the hammock. *Weise 45.*

Family Rosaceae

Chrysobalanus icaco L. Common on the ecotone between the beach zone and the *Coccoloba* zone. *Austin 4407.*

Family Leguminoseae

Caesalpinia bonduc (L.) Roxb. The Nicker Bean is common along the beaches of Palm Beach County, but apparently more common south of Boynton Beach. *Weise s.n.; Austin 4413.*

Canavalia maritima (Aubl.) Thouars. Common all along the beach zone. *Weise s.n.*

Crotalaria pumila Ortega. Scattered, but locally common. Found mostly along paths. *Pfefferle s.n.*

Dalbergia ecastophyllum (L.) Taub. On the lee side of the southern end of the hammock. *Austin 4399.*

Erythrina herbacea L. Uncommon. Scattered plants occur on the ocean side of the hammock near the ecotone between the beach and the *Coccoloba* zone. *Weise s.n.* (4.24.69).

Lysiloma latisiliqua (L.) Benth. (=*L. bahamensis* Benth.?). One tree near the road on the northwest side of the hammock. This is apparently the northern limit reported for the species. *Carrow & Marsh s.n.*; *Austin 4672*; Det. D. G. Burch.

Pithecellobium keyense Britt. Fairly common on the ocean side of the *Coccoloba* zone, scattered elsewhere throughout the hammock. *Austin 4400.*

Sophora tomentosa L. One individual plant was found at the northern end of the hammock. *Austin 4381.*

Family Zygophyllaceae

Tribulus cistoides L. Locally common in the areas of high disturbance at the southern end of the hammock. Absent elsewhere. *Austin 4395.*

Family Rutaceae

Amyris elemifera L. Uncommon. *Weise 92.*

Zanthoxylum fagara (L.) Sarg. A common plant in all parts of the hammock except the dense central part of the *Coccoloba* zone. *Weise 86.*

Family Simaroubaceae

Simarouba glauca DC. Scattered, but fairly common within the hammock. *Weise 63.*

Suriana maritima L. Rare. Occurring at the inner edge of the storm beach. *Weise s.n.* (4.28.69).

Family Burseraceae

Bursera simaruba (L.) Sarg. One of the two most common trees in the hammock. Often found from the second dune to the lower part of the lee side on the inner dune. *Weise 84.*

Family Polygalaceae

Polygala grandiflora Walt. Scattered plants are uncommon in the southern end of the hammock. *Austin 4671.*

Family Euphorbiaceae

Chamaesyce bombensis (Jacq.) Dugand. (=*C. ammanioides*). Scattered, but common along the beach. *Weise 7.*

Chamaesyce mesembryanthemifolia (Jacq.) Dugand. (=*C. buxifolia*). Common along the beach. *Weise 125.*

Cnidoscolus stimulosus (Mich.) Raf. Common in sunny areas along margins of the hammock. *Austin 4388.*

Croton punctatus Jacq. Fairly common in sunny margins of the hammock. *Weise s.n.* (4.24.69).

Phyllanthus abnormis Baillon. One plant found at the northern end of the hammock near the outer edge of the first dune. *Austin 4380.*

Poinsettia cyathophora (Murr.) Kl. & Gke. Uncommon in sunny margins of the hammock. *Weise 81.*

Family Anacardiaceae

Metopium toxiferum (L.) Krug & Urban. Perhaps the most common tree in the hammock. Very common on the lee side of the inner dune. *Weise s.n.*

Schinus terebinthifolius Raddi. An introduced species from southern South America; now widely naturalized in southern Florida because birds spread the seeds. Scattered throughout the hammock. *Weise 108.*

Toxicodendron radicans (L.) Knutze subsp. *radicans.* Fairly common on the lee side of the inner dune.

Family Rhamnaceae

Krugiodendron ferreum (Vahl.) Urban. Common along with *Randia aculeata* on the outer edge of the *Coccoloba* zone. *Weise s.n.*; det. O. Lakela.

Family Vitaceae

Parthenocissus quinquefolia (L.) Planch. Uncommon and somewhat depaupered where encountered; on the ocean side of the *Coccoloba* zone. *Austin 4402.*

Vitis coriacea Shuttlw. Some large vines are found near the center of the hammock on the lee side of the inner dune. *Austin 4667.*

Family Passifloraceae

Passiflora pallida L. One plant climbing on the *Coccoloba uvifera* near the N end of the hammock, on the ocean side. *Austin 4436.*

Family Caricaceae

Carica papaya L. Scattered plants occur throughout the hammock. Not very common. *Weise 100.*

Family Loasaceae

Mentzelia floridana Nutt. Scattered, but fairly common around margins of the hammock. *Weise s.n.* (4.24.69).

Family Cactaceae

Acanthocereus floridanus Small. Not common, but there are scattered patches with several individuals per patch on the lee side of the inner dune. *Austin 4401.*

Opuntia dillenii (Ker.) Haw. Common in the "prickly" area between the *Coccoloba* zone and the beach. *Weise 26.*

Family Combretaceae

Conocarpus erecta L. Near the center of the hammock near the road. *Carrow & Marsh s.n.* (4.28.70); *Austin 4416.*

Family Myrtaceae

Eugenia axillaris (Sw.) Willd. Occuring in large patches from the middle dune inland. Often in pure stands. *Weise 116.*

Eugenia myrtoides Poir. Often sympatric with *E. axillaris.* *Weise 44, 97.*

Family Myrsinaceae

Ardisia escallonioides Schlecht. & Cham. Fairly common and scattered throughout the hammock. *Weise 120.*

Myrsine guianensis (Aubl.) Kuntze. Clumps scattered through the hammock; apparently not as common as *Ardisia.* *Weise s.n.*

Family Plumbaginaceae

Plumbago scandens L. A few vines on the northern end. *Austin 4670.*

Family Sapotaceae

Mastichodendron foetidissimum (Jacq.) Cronq. Fairly common throughout the hammock. *Weise 114.*

Family Oleaceae

Forestiera segregata (Jacq.) Krug & Urban. Several plants clustered near the northern end of the hammock. *Austin 4431.*

Family Apocynaceae

Catharanthus roseus (L.) G. Don (=*Lochnera rosea* LC, 1965: 73; =*Vinca rosea* RAB, 1968: 847). A common weed in disturbed and sunny spots throughout. Introduced. *Austin 4387.*

Family Asclepiadaceae

Sarcostemma clausa Vail. Uncommon on lee side of inner dune. *Weise s.n.*

Family Convolvulaceae

Calonyction aculeatum (L.) House. Uncommon near road on the lee side of inner dune. *Austin 4398.*

Calonyction tuba (Schlecht.) Colla. Four plants growing with *Tournefortia.* Vitality not good but with some fruits on one plant. The only collection known from Palm Beach County. *Austin 4385.*

Ipomoea acuminata (Vahl.) Roem. & Schult. (=*I. cathartica* LC, 1965:75). Common along the margins of the hammock. Some plants climbing to canopy within the hammock. *Weise 122.*

Ipomoea pes-caprae (L.) Sweet. Common on the beach. *Weise 11.*

Family Boraginaceae

Heliotropium parviflora L. Rare. *Weise s.n.* (4.24.69).

Tournefortia gnaphaloides (L.) R. Br. One fairly large clump of plants occurs in about the middle area; there are smaller clumps at both ends of the large one. The plants grow near the upper (storm) beach limit near the prickly zone. The species is on the verge of extinction in the United States. *Weise 27.*

Family Solanaceae

Salanum bahamense L. Rare. *Weise s.n.* (4.24.69).

Family Rubiaceae

Chiococca alba (L.) Hitch. Fairly common throughout the hammock. *Austin 4389.*

Ernodea littoralis Sw. Fairly common in "blow-outs" and near the ocean side of the *Coccoloba* zone. *Weise 123.*

Psychotria nervosa Sw. Fairly common throughout the hammock. *Weise 115.*

Randia aculeata L. Common along the ecotone between the *Coccoloba* zone and the beach. *Weise 109; Austin 4390.*

Family Goodeniaceae

Scaevola plumieri Vahl. Common on the beach. *Weise s.n.* (4.28.69).

Family Compositae

Baccharis halimifolia L. Uncommon near the highway inside the inner dune. *Carrow & Marsh s.n.* (4.28.70).

Bidens pilosa L. (=*B. leucantha* L.). Fairly common on the southern end near the highway. *Weise s.n.* (4.24.69).

Helianthus debilis Nutt. Common on the upper beach and in the outer parts of the first dune. *Weise 127.*

Mikania cordifolia (L.) Willd. Fairly common around margins of hammock. *Austin 4406.*

Verbesina laciniata (Poir.) Gray (=*V. virginica* var. *laciniata* RAB, 1968: 1120). Not common. In isolated patches near the southern end. *Weise s.n.* (2.27.69).

ACKNOWLEDGMENTS

The Euphorbiaceae were determined by D. G. Burch; the Anacardiaceae by W. T. Gillis. Determination assistance by these men and by J. Beckner, O. Lakela, and D. B. Ward is gratefully acknowledged. The original manuscript was read and criticized by J. Beckner, W. T. Gillis, and D. B. Ward. This study was partially based on an ecology term paper submitted by the junior author, and supported by a grant from the Florida Atlantic University Division of Sponsored Research.

LITERATURE CITED

ALEXANDER, T. R. 1958a. High Hammock Vegetation of the Southern Florida Mainland. Quart. Jour. Florida Acad. Sci., vol. 21, pp. 293-298.

———. 1958b. Ecology of the Pompano Beach Hammock. Quart. Jour. Florida Acad. Sci., vol. 21, pp. 299-304.

COOKE, C. W. 1939. Scenery of Florida Interpreted by a Geologist. Geol. Bull., vol. 17, pp. 1-118.

———. 1945. Geology of Florida. Geol. Bull., vol. 29, pp. 1-339.

DALLA TORRE, K. W. V., AND H. HARMS. 1900-1907. Genera Siphonogamarum.

D'ARCY, W. G. 1967. Annotated checklist of the dicotyledons of Tortola, Virgin Islands. Rhodora, vol. 69, pp. 385-450.

DAVIS, J. H. 1943. The Natural Features of Southern Florida. Florida Geol. Bull., no. 25, pp. 6-301.

GILLIS, W. T. 1972. Biosystematics and ecology of Poison-Ivy and the Poison-Oaks (*Toxicodendron*: Anacardiaceae). Rhodora, vol. 73, pp. 370-443.

HARPER, R. M. 1927. Natural resources of southern Florida. 18th Ann. Report Florida Geol. Survey, pp. 27-206.

KURZ, H. 1942. Florida dunes and scrub, vegetation and geology. Geol. Bull., no. 23, pp. 1-154.

LAKELA, O., AND F. C. CRAIGHEAD. 1965. Annotated checklist of the vascular plants of Collier, Dade, and Monroe Counties, Florida. Fairchild Tropical Garden and University of Miami Press.

LIOGIER, BRO. A. 1963. Novitates Antillanae I. Bull. Torrey Bot. Club, vol. 90, pp. 186-192.

———. 1965a. Novitates Antillanae II. Bull. Torrey Bot. Club, vol. 92, pp. 288-304.

———. 1965b. Nomenclatural changes and additions to Britton and Wilson's "Flora of Puerto Rico and the Virgin Islands." Rhodora, vol. 67, pp. 315-361.

———. 1968. Novitates Antillanae III. Brittonia, vol. 20, pp. 148-161.

LONG, R. W. 1970. Additions and nomenclatural changes in the flora of southern Florida I. Rhodora, vol. 72, pp. 17-46.

PHILLIPS, W. S. 1940. A tropical hammock on the Miami (Florida) Limestone. Ecology, vol. 21, pp. 166-175.

RADFORD, A. E., H. E. AHLES, AND C. R. BELL. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill.

SAUER, J. 1967. Geographic reconnaissance of seashore vegetation along the Mexican Gulf Coast. Louisiana State University Press, Baton Rouge.

SMALL, J. K. 1933. Manual of the southeastern flora. Reprint by the University of North Carolina Press, Chapel Hill.

WARD, D. B. 1968. Checklist of the vascular flora of Florida I. Bull. Agr. Expt. Sta., no. 762, pp. 1-72.

Herbarium, Department of Biological Sciences, Florida Atlantic University, Boca Raton, Florida 33432.

Quart. Jour. Florida Acad. Sci. 35(2) 1972(1973)

A Sediment Trap for Use in Soft-bottomed Lakes

Frank G. Nordlie and John F. Anderson

The usual means of evaluating deposition rates work well for situations involving thick strata or rapid rates of sedimentation but are not satisfactory for short term studies, especially when low rates of deposition are involved. The investigator wishing to evaluate deposition rates over short periods (six months to a year, for example, as is necessary in carrying out community energetic studies) faces a paucity of suitable techniques. A few devices designed for this purpose have been described (e.g., Raymond and Stetson, 1931, and the later modification, Hough, 1955), but such large and elaborate devices were beyond our needs as well as means. Also they must be set on the bottom, which precludes their use in situations where the bottom deposits are not compact enough to prevent their sinking. Consequently we designed and constructed from polyethylene materials the simple and inexpensive sediment trap seen in Fig. 1. We would like to express our appreciation to Mr. Paul Laessle for preparing the drawings. The trap can be suspended at any depth to avoid any potentially offending flocculent layer over the compact bottom. The suspension rope is anchored on the bottom and attached to a surface float. The length of the anchor line is adjusted to eliminate slack and keep the trap in an upright position.

Construction

The trap is constructed from a piece of polyethylene tubing 24 in. (61 cm.) in length with an outside diameter of 3 1/4 in. (8.3 cm.) and wall thickness of 1/8 in. (0.35 cm.). The inside diameter of 3 in. (7.7 cm.) is equal to the outside diameter of a 16 oz. (ca. 500 ml.) screwtop polyethylene bottle. One of these bottles, with bottom cut out and cap removed, is inserted neck-first into the top of the polyethylene tube and driven down so that the bottom rim is below the top of the outside tube. A second bottle, also bottomless but in this case capped, is inserted neck down into the bottom of the polyethylene tube and driven in so that the shoulder of the bottle is above the lower edge of the tube. In our work we found that

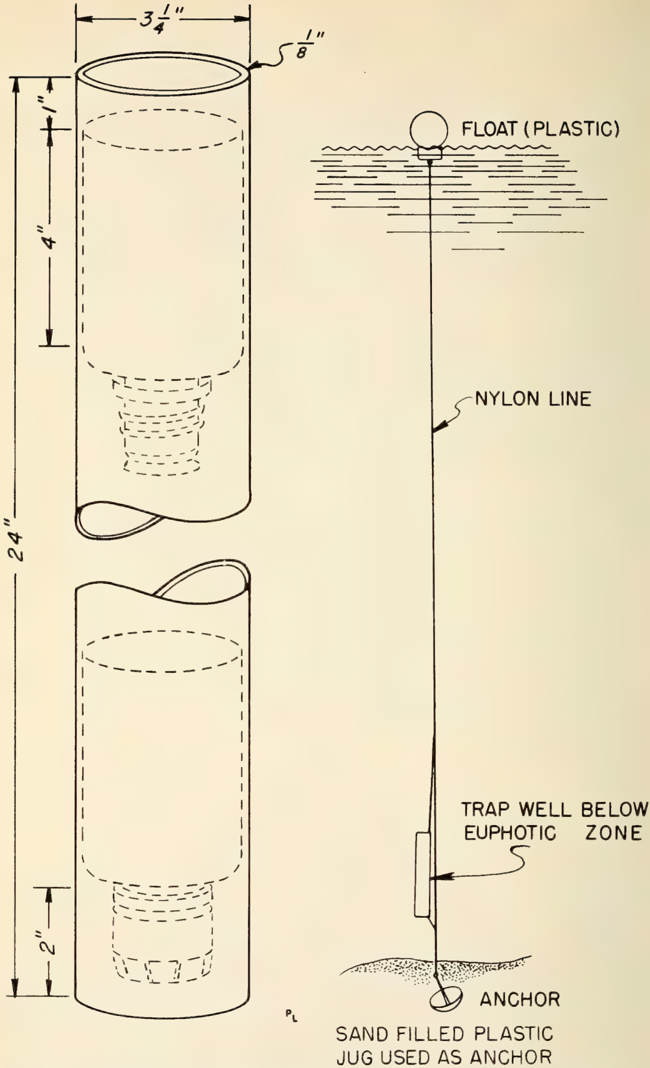


Fig. 1. Schematic drawing of construction and operation of polyethylene sediment trap.

the fit between the outer tube and the bottles was so snug that no adhesive was necessary.

Holes were drilled below the upper margin and above the lower margin of the outer tube to accommodate No. 3 nylon cord used to attach the trap to the suspension rope.

The traps are filled with filtered water prior to setting in order to sink them and to avoid contamination during setting (important in studies of rates or organic deposition). The traps are emptied by removing the screw cap from the lower bottle and collecting the contents. Several rinses may be necessary to remove all of the sediment.

Our traps were successfully operated for a period of one year in Lake Mize, Florida, a deep lake (ca. 25 m.) but with a small surface area (ca. 0.86 ha.). The traps may be less appropriate in large lakes with heavy wind action.

LITERATURE CITED

HOUGH, JACK L. 1955. Bottom sampling apparatus. *In*: Parker D. Trask (editor), Recent Marine Sediments—A Symposium. Soc. Economic Paleontologists and Mineralogists. Special Publ. No. 4, pp. 631-664.

RAYMOND, P. E., AND H. C. STETSON. 1931. A new factor in the transportation and distribution of marine sediments. Science, vol. 73, no. 1882, pp. 105-106.

Department of Zoology, University of Florida, Gainesville, Florida 32601.

Quart. Jour. Florida Acad. Sci. 35(2) 1972(1973)

New Records for Marine Fishes in South Carolina Waters

David M. Cupka and Robert K. Dias

Increased collecting along the eastern shore of North America should result in range extensions for a number of fish species (Anderson and Gutherz, 1965). These range extensions will result partly from stray, migrant and expatiate individuals, but some will represent unrecorded indigenous faunal components. *Paranthias furcifer* Valenciennes (Serranidae) and *Astroscopus guttatus* Abbott (Uranoscopidae) are recorded for the first time from South Carolina waters and represent significant range extensions. The recorded bathymetric range of *Kathetostoma albigutta* Bean (Uranoscopidae) is extended considerably with the captures of specimens in shallow inshore areas. The single specimen of *Paranthias furcifer* probably represents a stray individual of a species which normally does not range this far north. The small specimens of *Kathetostoma albigutta* may represent individuals which developed from pelagic larval forms which drifted into the shallow capture areas. The specimens of *Astroscopus guttatus*, because of their size and differences in localities and dates of collection, are felt to represent a species which is indigenous to the ichthyofauna of South Carolina.

A single specimen of *Paranthias furcifer* (263 mm standard length [SL]) was caught with rod and reel approximately 48 nautical miles ESE of Charleston (ca. la. 32° 23′, long 79° 02′; 9 November 1968; 46-55 m depth). The northernmost record for this species in the western Atlantic is Bermuda (Briggs, 1958), whereas the northernmost record off eastern North America is Miami (Smith, 1961). This specimen represents a range extension of approximately 420 nautical miles northward along the east coast of the United States. *P. furcifer* has also been reported from the Gulf of Mexico and the eastern Pacific (Smith, 1961).

Two specimens of *Astroscopus guttatus* (104 and 115 mm SL) were captured with a 4.6 m, 13 mm stretch mesh otter trawl in Jones Creek in Georgetown County (lat 33° 19.1′, long 79° 10.4′; 22 August 1969; water temperature 20.0 C). Another specimen (59 mm SL) was taken with a 6.1 m, 25 mm stretch mesh otter trawl in Russel Creek in Charleston County (lat 32° 36.4′, long 80° 19.0′; 19 April 1970; over sand and mud in 3.0-7.6 m depth; surface water

temperature 21.5 C). Berry and Anderson (1961) gave the range of this species as Long Island, New York, to Cape Lookout, North Carolina. The collection of this specimen in Russel Creek represents a range extension of approximately 200 nautical miles southwestward along the Atlantic coast of the United States.

A specimen of *Kathetostoma albigutta* (20 mm SL) was captured with a 19.8 m, 13 mm stretch mesh bag seine in Jones Creek (lat 33° 19.1′, long 79° 10.4′; 9 November 1970; 1.0 m depth; surface water temperature 16.8 C; surface salinity 32.3 ppt) and another of the same species (21 mm SL) while seining at Hunting Island Beach in Beaufort County (lat 32° 22.5′, long 80° 26.1′; 19 February 1971; 0.2-0.8 m depth; surface water temperature 10.5 C; surface salinity 26.9 ppt). Previous workers (Berry and Anderson, 1961; Moe and Martin, 1965; Struhsaker, 1969) have shown this species to occur in deeper water. This, however, may be partially attributed to the fact that the vessels on which these specimens were collected operated mainly in offshore waters. Berry and Anderson (1961) examined 87 specimens (29-204 mm SL) collected from 37-384 m with the majority coming from 55 m to 110 m. Moe and Martin (1965) collected three specimens (70-239 mm SL) in 48 m of water in the Tampa Bay area. Struhsaker (1969) reported *K. albigutta* as common, being taken in more than fifty per cent of the trawl samples in the primary habitat of the species, which according to Struhsaker's definition is the lower-shelf and shelf-edge. As far as we can determine our specimens represent the first inshore records and the smallest individuals yet recorded of *K. albigutta*.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance of Dr. Harry W. Freeman, College of Charleston, who made available two of the specimens of *Astroscopus guttatus*. We are also indebted to Dr. William D. Anderson, Jr., Grice Marine Biological Laboratory, and Mr. Charles M. Bearden, South Carolina Marine Resources Division, who critically read the manuscript and offered valuable suggestions.

LITERATURE CITED

ANDERSON, W. D. JR., AND E. J. GUTHERZ. 1965. New Atlantic Coast ranges for fishes. Quart. Jour. Florida Acad. Sci. (1964), vol. 27, no. 4, pp. 299-306.

BERRY, F. H., AND W. W. ANDERSON. 1961. Stargazer fishes from the western North Atlantic (Family Uranoscopidae). Proc. U. S. Nat. Mus.. vol. 112, no. 3448, pp. 563-586.

BRIGGS, J. C. 1958. A list of Florida fishes and their distribution. Bull. Florida State Mus., vol. 2, no. 8, pp. 223-318.

MOE, A. M., AND G. F. MARTIN. 1965. Fishes taken in monthly trawl samples offshore of Pinellas County, Florida, with new additions to the fish fauna of the Tampa Bay area. Tulane Stud. Zool., vol. 12, no. 4, pp. 129-151.

SMITH, C. L. 1961. Synopsis of biological data on groupers (*Epinephelus* and allied genera) of the western North Atlantic. FAO Fish. Biol. Synopsis No. 23, 67 pp.

STRUHSAKER, P. 1969. Demersal fish resources: composition, distribution, and commercial potential of the continental shelf stocks off southeastern United States. Fish. Ind. Res., vol. 4, no. 7, pp. 261-300.

South Carolina Wildlife Resources Department, Marine Resources Division 217 Fort Johnson Road, Charleston, South Carolina 29412.

Quart. Jour. Florida Acad. Sci. 35(2) 1972(1973)

FLORIDA ACADEMY OF SCIENCES

INSTITUTIONAL MEMBERS FOR 1972

American Medical Research Institute
Archbold Expeditions
Barry College
Edison Community College
Florida Atlantic University
Florida Institute of Technology
Florida Presbyterian College
Florida Southern College
Florida State University
Florida Technological University
Jacksonville University
Manatee Junior College
Miami-Dade Junior College
Mound Park Hospital Foundation
Ormond Beach Hospital
Rollins College
St. Leo College
Stetson University
University of Florida
University of Miami
University of South Florida
University of Tampa
University of West Florida

FLORIDA ACADEMY OF SCIENCES

Founded 1936

OFFICERS FOR 1972

Membership applications, subscriptions, renewals, changes of address, and orders for back numbers should be addressed to the Treasurer

---

Correspondence regarding exchanges should be addressed to

Gift and Exchange Section, University of Florida Libraries
Gainesville, Florida 32611

Quarterly Journal
of the
Florida Academy of Sciences

Vol. 35 December, 1972 No. 4

CONTENTS

Notes on parasites of gray squirrels from Florida
J. C. Parker, E. J. Riggs, and R. B. Holliman 161

Occurrence of two trematodes in Florida anoles
Richard Franz and Sam R. Telford, Jr. 163

Reproductive rates in white-tailed deer of Florida *Richard F. Harlow* 165

Food of the barn owl on Grand Cayman, B. W. I. *David W. Johnston* 171

Balanomorph barnacles on *Chrysemys alabamensis*
Crawford G. Jackson, Jr., and Arnold Ross 173

Synopsis of the species of *Trachurus* (Pisces, Carangidae)
Frederick H. Berry and Linda Cohen 177

Defensive behavior in *Rana areolata* and *Hyla avivoca* *Ronald Altig* 212

Commercial fishery on Lake Okeechobee, Florida *Lothian A. Ager* 217

Nuclear DNA and developmental rate in frogs *K. Bachmann* 225

Some airborne algae from North Central Florida
R. T. Parrando and J. S. Davis 232

Bird remains from pre-Columbian middens in the Virgin Islands
Pierce Brodkorb 239

Published March 15, 1974

QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

Editor: Pierce Brodkorb

The Quarterly Journal welcomes original articles containing significant new knowledge, or new interpretation of knowledge, in any field of Science. Articles must not duplicate in any substantial way material that is published elsewhere.

INSTRUCTIONS TO AUTHORS

Rapid, efficient, and economical transmission of knowledge by means of the printed word requires full cooperation between author and editor. Revise copy before submission to insure logical order, conciseness, and clarity.

MANUSCRIPTS should be typed double-space *throughout*, on one side of numbered sheets of 8½ by 11 inch, smooth, bond paper.

A CARBON COPY will facilitate review by referees.

MARGINS should be 1½ inches all around.

TITLES must not exceed 55 characters, including spaces.

FOOTNOTES should be avoided. Give ACKNOWLEDGMENTS in the text and Address in paragraph form following Literature Cited.

LITERATURE CITED follows the text. *Double-space* and follow the form in the current volume. *For articles* give title, journal, volume, and inclusive pages. *For books* give title, publisher, place, and total pages.

TABLES are charged to authors at $25.00 per page or fraction. Titles must be short, but explanatory matter may be given in footnotes. Type each table on a separate sheet, *double-space, unruled,* to fit normal width of page, and place after Literature Cited.

LEGENDS for illustrations should be grouped on a sheet, *double-spaced,* in the form used in the current volume, and placed after Tables. Titles must be short but may be followed by explanatory matter.

ILLUSTRATIONS are charged to authors ($17.00 per page or fraction). DRAWINGS should be in India ink, on good board or drafting paper, and lettered by lettering guide or equivalent. Plan linework and lettering for reduction, so that final width is 4⅛ inches, and final length does not exceed 6⅝ inches. Do not submit illustrations needing reduction by more than one-half. PHOTOGRAPHS should be of good contrast, on glossy paper. Do not write heavily on the backs of photographs.

PROOF must be returned promptly. Leave a forwarding address in case of extended absence.

REPRINTS may be ordered when the author returns corrected proof.

Published by the Florida Academy of Sciences

Printed by the Storter Printing Company

Gainesville, Florida

QUARTERLY JOURNAL
of the
FLORIDA ACADEMY OF SCIENCES

Vol. 35 December, 1972 No. 4

Notes on Parasites of Gray Squirrels from Florida

J. C. Parker, E. J. Riggs, and R. B. Holliman

In December, 1969, three male and one female gray squirrels, *Sciurus carolinensis carolinensis* Gmelin, 1788, were collected on a farm woodlot in Marion County near Ocala, Florida. These squirrels were examined for intestinal and blood protozoa and intestinal helminths, which revealed at least two species of eimerian coccidia, one species of cestode, one species of acanthocephalan and four species of nematodes.

A review of the literature yielded only two references concerning internal parasites in this host from Florida. Bond and Bovee (1958) reported *Eimeria* sp. from this host and Chandler (1947) reported *Moniliformis clarki* (Ward, 1917).

Analysis of the fecal material revealed the oocysts of two forms of eimerian coccidia. The first was observed in all hosts examined and was ellipsoidal in shape, resembling the organism described as *Eimeria* sp. by Bond and Bovee (1958). The second resembled the characteristic pyriform-shaped oocysts of *Eimeria ontarioensis* Soon and Dorney (In press) and occurred in only one of the hosts examined. Also helminth eggs were observed in all fecal samples.

The examination of the visceral organs revealed the cestode, *Raillietina bakeri* Chandler, 1942, in the small intestine of 2 squirrels; one tapeworm was recovered from one host, two from the other. The acanthocephalan, *Moniliformis clarki* Ward, 1917, occurred in the small intestine of two hosts; 3 worms in one squirrel, one in the other. The largest of these worms measured 325 mm in length and filled most of the lumen of the small intestine. The average length of the 4 worms was 167 mm.

The nematode, *Heligmodendrium hassalli* (Price, 1929) was found in the small intestine of 3 hosts (1, 44, and 115 worms per host). Twenty-five specimens of *Strongyloides robustus* Chandler, 1942, were recovered from the small intestine of one squirrel. One specimen of *Syphacia* (*Syphacia*) *thompsoni* Price, 1928, was found in the cecum of each of two hosts, and one *Trichostrongylus calcaratus* Ransom, 1911, was recovered from the cecum of a single host.

The examination of Wright's stained blood smears for presence of *Hepatozoon* and microfilariae was negative.

This report tentatively extends the present known distribution of *Eimeria ontarioensis* from Canada to Florida. Apparently, *Syphacia* (*Syphacia*) *thompsoni, Heligmodendrium hassalli, Strongyloides robustus*, and *Trichostrongylus calcaratus are* new records for this host in Florida. *Raillietina bakeri* appears to be a new host record.

We are grateful to Dr. R. S. Dorney of the University of Waterloo, Ontario, Canada, for information on his new coccidian, *E. ontarioensis.*

Literature Cited

Bond, B. B., and E. C. Bovee. 1958. A redescription of an eimerian coccidian from the flying squirrel, *Glaucomys volans,* designating it *Eimeria parasciurorum* nov. sp. Jour. Protozool., vol. 4, pp. 225-229.

Chandler, A. C. 1947. Notes on *Moniliformis clarki* in North American squirrels. Jour. Parasit., vol. 33, pp. 278-281.

Soon, B. L., and R. S. Dorney. In press. *Eimeria ontarioensis* n. sp., *E. wongi* n. sp. and *Eimeria* sp. (Protozoa: Eimeriidae) from the Ontario gray squirrel *Sciurus carolinensis.* Jour. Protozool.

Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 24061.

Occurence of Two Trematodes in Florida Anoles

Richard Franz and Sam R. Telford, Jr.

The digenetic trematode *Alloglyptus crenshawi* (Macroderoididae) was described by Byrd (1950) from a series of 30 specimens taken from the small intestine of a single *Anolis carolinensis* collected in Baker County, Georgia. No additional collections of this parasite have been reported, to the best of our knowledge.

During autopsy of over 100 *Anolis carolinensis* from various Florida localities, three were found to be infected with *A. crenshawi*. Eight specimens in all were removed from the upper small intestines of lizards collected along the north shore of Redwater Lake, 4 mi. E of Hawthorne, Putnam County, Florida. An additional 23 anoles from this locality were uninfected. All were collected on a sandy ridge in a palmetto-live oak thicket within 50 feet of the shoreline. These trematodes agree closely with Byrd's description, but average somewhat smaller (2-3 mm) in length. All specimens contained numerous mature ova.

Examination of 15 gastro-intestinal tracts from *A. carolinensis*, including those of the infected lizards, revealed that ants and mosquitoes comprised 58 per cent of the ingested food items, followed by winged termites (21 per cent). The remainder of the food items included hymenopteran wings and two small snails, probably *Mesophix* sp. Spiders and lepidopteran larvae, commonly fed upon by anoles, were not found in these samples. Sellers (1971) reported that *Anolis carolinensis* serves as host to another trematode, *Urotrema wardi* Viqueras, 1940, in Florida. This species was previously known only from *Anolis porcatus* of Cuba. We too have encountered *Urotrema* in Florida anoles: six specimens were removed from an *A. carolinensis* collected at Hart Springs, Gilchrist County, Florida. While slight differences in measurement are present, these trematodes are probably best assigned to *U. wardi*, in the opinion of Dr. J. M. Kinsella, Department of Veterinary Science, University of Florida, who confirmed our identification of them.

The specimens have been accessioned into the collections of the Florida State Museum, to which institution we are indebted for support of our continuing studies upon the trematodes of Florida reptiles.

LITERATURE CITED

BYRD, E. E. 1950. *Alloglyptus crenshawi*, a new genus and species of digenetic trematode (Plagiorchiinae) from the chamacleon. Trans. Amer. Microscop. Soc., vol. 69, no. 3, pp. 280-287.

SELLERS, L. G. 1971. Three helminths recovered from *Anolis carolinensis*. Jour. Parasitol., vol. 57, no. 2, p. 355.

Florida State Museum, University of Florida, Gainesville, Florida 32601.

Quart. Jour. Florida Acad. Sci. 35(4) 1972 (1974)

Reproductive Rates in White-tailed Deer of Florida

Richard F. Harlow

This paper presents possible reasons for the low reproduction rates of white-tailed deer (*Odocoileus virginianus*) in central Florida and attempts to show that overpopulation and quantity of available forage are not involved.

In most regions of the Southeast, quantity of available food is sufficient, yet average reproductive rates are lower than for most northern areas. Sileo (1966) assembled reproductive data on 8,564 white-tailed deer from 20 eastern states. He found that fecundity rates of white-tailed deer in southern forests were significantly lower than those of deer in either the northern forests or the central hardwood forests. In the South, fecundity of deer in the Coastal Plain was lowest and that of deer in the Piedmont was highest. Forest type and soil were found to exert the greatest influence on deer fecundity. Short (1969) stated that most upland forests in the South have infertile soils and produce roughages that are seasonally deficient in net energy, protein, and phosphorus for deer.

In the present study, 99 does were collected from central and north Florida for examination during February when food supplies were considered lowest. All deer were inspected for fat content of the bone marrow, pericardial and peritoneal fat, numbers of ecto- and endoparasites, body size, weight, and stomach contents.

Variation in Reproductive Rates

No deer suffered from malnutrition. After adjustment for age differences, body weight and physical measurements of the 61 does from central Florida did not differ significantly ($P<.05$) from the 38 does from north Florida. However, the average reproductive rate of does from central Florida was 0.98 fetus per doe as compared to slightly over 1.5 in deer from north Florida. The reproductive rate of the central Florida sample was similar to that (1.06) reported in New York where winter starvation was chronic (Cheatum and Severinghaus 1950). Reproductive rates of deer in north Florida were comparable to those of northern white-tails on ranges where winter foods were adequate.

AVAILABILITY OF FORAGE

Quantity and variety of available forage does not appear to be limiting factors to herd fecundity in central Florida. Quantities of available forage on four study areas during winter ranged from 80 pounds per acre (oven-dry) on the longleaf pine-turkey oak site to from 400 to 1,800 pounds per acre on two flatwood sites and one sand pine-scrub oak type. The number of species of major woody plants available to deer ranged from 20 to 30 (Harlow 1959), and the study sites contained small acreages of bayheads, hammocks, and cypress swamps which added to habitat diversity.

DEER POPULATIONS

Deer numbers on three of the study areas in central Florida were moderate to low, varying from one deer per 40 acres to one per 100 acres. Only one area, the longleaf pine-turkey oak, had a population density considered high—one deer per 13 to 20 acres (Harlow 1959). The reproductive rate of adult does from this area averaged 0.86, even lower than that of does from the other areas which averaged 0.98. Also, a comparison of the weights of adult does in the same age classes from the different sites showed that deer from the longleaf pine-turkey oak type averaged lighter in weight but not significantly (Harlow and Jones 1965). However, an examination of the bone marrow of 20 deer sacrificed from this area of comparatively high population during February 26 to March 3, 1962, by the Southeastern Cooperative Deer Disease Study, indicated the deer were in good physical condition. The fat content of the bone marrow exceeded 90 per cent. Low reproductive rates are often associated with poor physical condition.

EFFECTS OF HUNTING

Deer hunting with dogs occurred annually on all vegetation types, except the longleaf pine-turkey oak area which exhibited the lowest reproductive rate. Hunting with dogs has been blamed for poor deer reproduction; however, this has not been adequately demonstrated. Such hunting occurs in north Florida where reproductive rates are higher. On areas where deer hunting with dogs is allowed, the peak of the rutting season has passed by the time hunting season starts (Harlow and Jones 1965).

SOIL FERTILITY

Low fertility of the soils of central Florida may be an important factor limiting herd reproduction. The upland soils of northwest Florida (particularly Leon, Gadsden, and Madison Counties where the reproductive data from north Florida were collected) have much more clay present in the subsoil than do upland soils in central Florida, and, according to analysis, the upland soils of northwest Florida also have higher potential fertility (Alsberg et al., 1952).

Another possible limiting factor may be a lack of certain mineral elements in the soil. Data supporting this possibility were reported in a study of range cattle management in Alachua County, Florida, by Camp (1932). His studies showed that the calf crop averaged only 34.4 per cent in flatwoods and 37.1 per cent in pine-oak uplands, while calf crops in prairies averaged 54.1 per cent and those in hammock habitats averaged 71.6 per cent. "Salt sick," or nutritional anemia, was reported to be common in pine-palmetto flatwoods and pine-oak uplands, where the soils are mostly deep white and gray sands without red clay which is found in prairies and hammocks. Becker et al. (1931) found that "salt sick" occurs on white and gray sandy soils and on many soils which have no clay, and that affected cattle recovered when changed to clay ranges. These soils low in clay are deficient in iron, or in iron and copper, and it is believed that the "salt sick" condition was caused by the scarcity of these elements.

Thornton et al (1960), however, states that "Preliminary results of experiments underway but not yet completed, indicate a correlation between the occurrence of 'salt sickness' in cattle and the cobalt content of the soils upon which the animals were pastured. These studies also indicate a relation to available phosphorus and copper but the correlation was not as high as with cobalt. Cattle were anemic when pastured on all soils containing less than 0.02 parts per million of available cobalt and only one case of anemia was found on soils containing more than this amount." If cobalt is the trace element responsible for the poor performance of deer, this is not the first instance in which it has been suspected of playing a part. Smith et al. (1956) considered that inadequate cobalt levels partially explain the poor reproductive performance of deer in certain sections of North Carolina.

Lignin Content and the Availability of Mast

Another factor influencing low reproductive rates of deer in central Florida may be the high lignin content associated with forage in the Coastal Plain. Halls et al. (1957) found that lignin content of browse plants in the Georgia Coastal Plain varied from 21 per cent in the summer to 26 per cent in the winter. They state that this high lignin content renders the browse nearly indigestible and that large quantities of lignin tend to decrease the digestibility of other nutrients. The browse plants studied were also relatively low in the more digestible portion of the carbohydrate fraction and, therefore, low in energy. It is known that lignin reduces digestibility and energy value as well as intake.

Where forage is high in lignin content and low in energy over large areas, mast crops may assume a very important role, depending on the extent that mast contributes to the annual diet of a deer herd. Harlow and Tyson (1959) found a significant correlation between the abundance of acorn and palmetto mast and the weight and reproduction of deer in central Florida. When mast production was low, weights of harvested deer were lower than when mast was abundant. Also, the percentage of harvested 1 1/2-year-old bucks declined the second hunting season following the year when mast growth was low. According to Morrison (1957), acorns have no digestible protein but are high in fat, which produces energy. In central Florida, a lack of acorns and palmetto berries as a result of periodic mast failures may further compound a detrimental effect on reproduction of the naturally high lignin content of the forage.

Although high lignin content of the forage and mast failures also occur in north Florida where reproductive rates are higher, I believe that it is the additional factor of soil deficiencies that accounts for the lower reproductive efficiency of deer in central Florida.

This does not necessarily imply that deer populations from comparatively poor range cannot reach densities approaching those on better range. I am only theorizing that herd increases will occur at a much slower rate and that high densities will be sustained for shorter periods.

Conclusions

It is obvious that more detailed information is needed on the

nutritional requirements of deer in Florida and the inherent capacity of the different vegetational types to support white-tails. Such data are necessary before we can develop adequate and economically feasible management techniques to improve the range and reproductive rate of particular populations. Possible avenues of further investigation include:

1. Methods of increasing production of long-lasting, palatable, nutritious foods such as grasses and clovers on deer range.
2. Methods of maintaining natural deer foods in the most palatable and nutritious state or perhaps through such techniques as prescribed burning, fertilizing, and mowing.
3. Methods of increasing certain natural foods which are particularly high in energy content, such as acorn mast and palmetto berries.
4. Methods of correcting mineral deficiencies.

ACKNOWLEDGMENTS

Data on the reproductive rates, physical condition, and population estimates of deer, and on the habitat characteristics of the study areas, are a contribution of Federal Aid Project W-41-R, Florida Game and Fresh Water Fish Commission, and the Southeastern Cooperative Deer Disease Study, University of Georgia, Athens, Georgia.

LITERATURE CITED

ALSBERG, H. C., J. M. SCOTT, B. W. ALLIN, AND O. C. BRYAN. 1952. Agricultural conservation and soils of Florida. Florida Dept. Agr. Bull, no. 91, 115 pp.

BECKER, R. B., W. M. NEAL, AND A. L. SHEALY. 1931. 1. Salt sick: Its causes and prevention. II. Mineral supplements for cattle. Florida Agr. Exp. Sta. Bull. no. 231, 23 pp.

CAMP, P. D. 1932. A study of range cattle management in Alachua County, Florida. Florida Agr. Exp. Sta. Bull. no. 248, 28 pp

CHEATUM, E. L., AND C. W. SEVERINGHAUS. 1950. Variation in fertility of white-tailed deer related to range conditions. N. Amer. Wildlife and Natur. Resources Conf. Trans. 15, pp. 170-190.

HALLS, L. K., F. E. KNOX, AND V. A. LAZAR. 1957. Common browse plants of the Georgia Coastal Plain, their chemical composition and contribution to cattle diet. U. S. Forest Serv. Southeast. Forest Exp. Sta. Pap. no. 75, 18 pp.

HARLOW, R. F. 1959. An evaluation of white-tailed deer habitat in Florida. Florida Game and Fresh Water Fish Comm. Tech. Bull. no. 5, 64 pp.

HARLOW, R. F., AND F. K. JONES. 1965. The white-tailed deer in Florida. Florida Game and Fresh Water Fish Comm. Tech. Bull. no. 9, 240 pp.

HARLOW, R. F., AND E. L. TYSON. 1959. A preliminary report on the effect of mast abundance on the weight and reproduction of deer in central Florida. Ann. Conf. Southeast. Assn. Game and Fish Comm. Proc., no. 13, pp. 62-69.

MORRISON, F. B. 1957. Feeds and feeding. Morrison Publishing Co., Ithaca, New York, 630 pp.

SHORT, H. L. 1969. Physiology and nutrition of deer in southern upland forests. U. S. Forest Serv. Southern Forest Exp. Sta., Nacogdoches, Texas. Symposium on White-tailed Deer in the Southern Forest Habitat Proc., pp. 14-18.

SILEO, L., JR. 1966. Fertility analysis of the ranges of white-tailed deer in the eastern United States. M. S. Thesis, Univ. of Connecticut, Storrs. 50 pp.

SMITH, F. H., K. C. BEESON, AND W. E. PRICE. 1956. Chemical composition of herbage browsed by deer in two wildlife management areas. Jour. Wildlife Management, no. 20, pp. 359-367.

THORNTON, G. D., W. W. MCCALL, R. E. CALDWELL, AND F. B. SMITH. 1960 Soils and fertilizers. Florida Dep. Agr. Bull., no. 137, 70 pp.

Southeastern Forest Experiment Station, U. S. Department of Agriculture, 105 Wilson Avenue, Blacksburg, Virginia 24060.

Quart. Jour. Florida Acad. Sci. 35(4) 1972 (1974)

Food of the Barn Owl on Grand Cayman, B. W. I.

David W. Johnston

Despite the wide distribution of the Barn Owl (*Tyto alba*) in the West Indies, its breeding and feeding habits are poorly documented for specific islands. The most complete accounts of foods are from fossil and subfossil cave deposits in Jamaica (Williams, 1952) and from numerous contemporary sites on Hispaniola (Wetmore and Swales, 1931). On Grand Cayman, an island of 71 square miles and 180 miles south of Cuba, the Barn Owl has been known as a resident since the earliest ornithological explorations in 1886, yet prior to this paper neither nesting sites nor foods have been reported for the island. The present brief account is ecologically significant because this owl is the island's sole resident avian predator. Furthermore, the mammalian fauna, part of the owl's diet, is poorly known.

One nest site, located inside an abandoned boat at the edge of North Sound, was examined on 18 December 1970. In January 1970 it contained a single egg that subsequently disappeared. This site must have been used previously because the wooden floors nearby were paved with bones, chiefly those of *Rattus rattus* and *Mus musculus.* Also present were remains of a single hermit crab (Paguridae) and the mandible of *Elaenia martinica.*

Near Savannah, on the south end of the island, an active nest was located on 19 December 1970. It was in a deep hollow of an old mango tree (*Mangifera indica*) and contained three downy young. Beneath neighboring mango trees were fresh and broken owl pellets plus scattered bones. These included many skeletal parts from *Rattus rattus* (30 skulls) and *Mus musculus,* one skull each of *Rattus norvegicus, Aristelliger praesignis, Brachyphylla nana, Artibeus jamaicensis,* and an assortment of avian bones. The latter belonged to *Leucophoyx thula, Quiscalus niger, Mimus polyglottos, Dumetella carolinensis, Dendroica* (probably *palmarum*), *Coereba flaveola,* and *Centurus superciliaris.* The avian remains constituted approximately 40 per cent of the identified food items.

The two bats (*Brachyphylla* and *Artibeus*) have not been previously reported from Grand Cayman (Hall and Kelson, 1959) although both Donald Buden (in 1970) and Albert Schwartz (in

1961) have collected *Artibeus* on the island. Buden also took *Brachyphylla* there in 1970. Miller (1902) recorded both of these bat species from Barn Owl pellets on Cuba.

Of ecological significance is the relatively high proportion of avian remains in the Cayman material. For numerous continental sites the Barn Owl is renowned for its concentration on rodent prey and for a low percentage (ca. 1 per cent) of avian prey (Wallace, 1948), but on islands birds may become more important or even exclusive food items (Howell, 1920). On Hispaniola in addition to rats, mice, lizards, bats and frogs, 29 species of birds were identified from Barn Owl pellets (Wetmore and Swales, 1931). It seems likely that on some islands, such as Grand Cayman where small mammal prey is reduced in diversity and total numbers, the Barn Owl becomes alternatively a significant predator of birds and other nonmammalian vertebrates.

Assistance in the identification of food items was given by Walter Auffenberg, Edward Bender, Pierce Brodkorb, and Ronald Pine. A Biomedical Sciences Grant from the University of Florida supported the field work.

LITERATURE CITED

HALL, E. RAYMOND, AND KEITH R. KELSON. 1959. The mammals of North America. Ronald Press, New York, vol. 1, pp. 129-137.

HOWELL, A. B. 1920. Habits of *Oceanodroma leucorhoa beali vs. O. socorroensis*. Condor, vol. 22, pp. 41-42.

MILLER, GERRIT S., JR. 1902. Twenty new American bats. Proc. Acad Nat. Sci. Philadelphia, vol. 54, pp. 409-410.

WALLACE, GEORGE J. 1948. The barn owl in Michigan. Mich. State College, Tech. Bull. no. 208, pp. 50-55.

WETMORE, ALEXANDER, AND BRADSHAW H. SWALES. 1931. The birds of Haiti and the Dominican Republic. Bull. U. S. Nat. Mus., vol. 155, pp. 234-236.

WILLIAMS, ERNEST E. 1952. Additional notes on fossil and subfossil bats from Jamaica. Jour. Mamm., vol. 33, pp. 171-179.

Department of Zoology, University of Florida, Gainesville, Florida 32611.

Balanomorph Barnacles on *Chrysemys alabamensis*

Crawford G. Jackson, Jr., and Arnold Ross

The Alabama red-bellied turtle, *Chrysemys alabamensis* (Baur) ranges from Apalachee Bay, Florida to Mobile Bay, Alabama, in marshes and mangrove-bordered creeks and other bodies of brackish or fresh water (Conant, 1958). Although *C. alabamensis* was described prior to the turn of the century (Baur, 1893), it remained so poorly known that even its taxonomic validity was in doubt until the work of Carr and Crenshaw (1957). During studies on the insular herpetofauna in the upper Gulf of Mexico, we had the opportunity of studying a specimen of this seldom-observed turtle that was heavily fouled by the balanomorph barnacle *Balanus improvisus* Darwin (Fig. 1). Fouling by balanomorphs, and the occurrence near an offshore island, suggest that *C. alabamensis* is relatively salt tolerant as Carr (1952) indicated for the congeneric *C. concinna mobilensis* (Holbrook) and *C. concinna suwanniensis* (Carr), which also occur in coastal areas of the upper Gulf. Previously Carr (1940) had noted the presence of barnacles on several individuals of the latter in a heap of shells at Cedar Key, Florida.

The turtle was collected by W. T. Seibels on 17 December 1968 in shallow water off Dauphin Island, Mobile County, Alabama (approximately 30°10′51.6″N, 88°15′12″W), which is one of several islands fronting Mobile Bay. The specimen, an adult male now housed in the collections of the University of South Alabama (USA-1253), measures as follows (in mm): carapace length 262, carapace width 186, plastron length 228, anterior plastral width 105, posterior plastral width 104, bridge width 84, shell depth 107, head width 34.5. The right side of the carapace shows evidence of multiple injuries, all of which are well healed, and were probably incurred when the turtle was much younger.

Balanus improvisus ranges widely in the Caribbean and Atlantic, and has been reported from other regions about the world (Utinomi, 1966; Carlton and Zullo, 1969). It is commonly found in the intertidal zone and in shallow water estuarine environments on inanimate objects as well as in association with oysters and other mollusks adapted to reduced salinities (Newman, 1967; Carlton and Zullo, 1969). Because *B. improvisus* is able to conform osmotically

Fig. 1. Dorsal view of the Alabama red-bellied turtle *Chrysemys alabamensis* (Baur) fouled by the littoral barnacle *Balanus improvisus* Darwin.

and remain active in low salinity waters for indefinite periods, it is regarded as a highly successful estuarine species (Newman, 1967). But low resistance to dessication is probably the limiting factor to its successful settlement and widespread occurrence on turtles that spend long periods out of water.

More than 600 barnacles settled on the carapace of *C. alabamensis.* We measured 513 of these, which ranged in size from 1.0-10.2 mm, with a mean value of 4.2 mm. All of the specimens fall into five size classes, probably from successive larval settlements in one or more seasons. Under natural conditions at Beaufort, North Carolina, *B. improvisus* reaches a rostro-carinal diameter of 4-5 mm in about 20 days (Costlow and Bookhout, 1957). We estimate that nearly all of the present specimens are probably no less than two days and no more than 10 weeks old. Several individuals have reached a size that possibly indicates settlement during a previous season, and thus are much older than 10 weeks.

Cypris larvae of intertidal and shallow water balanomorphs not only select a particular site for attachment but orient at settlement in response to either light intensity, water movement or currents, surface contour or texture, or a combination of these (Crisp and Barnes, 1954; Crisp and Stubbings, 1957). During the growth period after attachment the barnacle may reorient in response to water currents (Moore, 1933). From our study of the present specimens it appears that 1) settlement was wholly within the interlaminal grooves or in striae in the surface of the laminae, 2) apparently all barnacles in the same groove are similarly oriented, 3) there is no predominant angle of orientation with respect to the antero-posterior axis of the turtle, and 4) none of the specimens appear to have changed their initial orientation.

Present evidence suggests that true turtle barnacles and whale barnacles orient initially in response to water currents (Crisp and Stubbings, 1957). In general, these barnacles adopt an orientation with the cirral net facing directly into the current, thereby maximizing the fishing capabilities of the net which is employed in gathering food. The barnacle, however, is capable of partially rotating the net and this may account for variations in the angle of orientation from the antero-posterior axis of the host. Although much of the work on barnacle settlement has been done with artificial, essentially planar surfaces, we believe that future studies

should be made on models with a laminar spindle configuration. Use of such models would go a long way in helping to explain the occurrence of intertidal as well as turtle barnacles on one area of the host and not on another, and would also help to explain gross variations in orientation of the barnacles from one position to another on the same turtle.

We thank A. Floyd Scott, Curator of Amphibians and Reptiles, University of South Alabama, Mobile, for permission to study the turtle, and Jack Lahr, San Diego State College Photographic Laboratories, for preparing the photograph.

LITERATURE CITED

BAUR, G. 1893. Notes on classification and taxonomy of the Testudinata. Proc. Amer. Philos. Soc., vol. 31, pp. 210-225.

CARLTON, J. T., AND V. A. ZULLO. 1969. Early records of the barnacle *Balanus improvisus* Darwin from the Pacific Coast of North America. California Acad. Sci. Occ. Paper 75, pp. 1-6.

CARR, A. F. JR. 1940. A contribution to the herpetology of Florida. Univ. of Florida Publ., Biol. Sci. Ser., vol. 3, no. 1, 1-118.

———. 1952. Handbook of turtles. Cornell Univ. Press, Ithaca, 542 pp.

CARR, A. F., AND J. W. CRENSHAW, JR. 1957. A taxonomic reappraisal of the turtle *Pseudemys alabamensis* Baur. Bull. Florida State Mus., vol. 2, no. 3, pp. 25-42.

CONANT, R. 1958. A field guide to reptiles and amphibians. Houghton Mifflin Co., Boston, 366 pp.

COSTLOW, J. D., JR., AND C. E. BOOKHOUT. 1967. Body growth versus shell growth in *Balanus improvisus*. Biol. Bull., vol. 113, no. 2, pp. 224-232.

CRISP, D. J., AND H. BARNES. 1954. The orientation and distribution of barnacles at settlement with particular reference to surface contour. Jour. Animal Ecol., vol. 23, no. 1, pp. 142-162.

CRISP, D. J., AND H. G. STUBBINGS. 1957. The orientation of barnacles to water currents. Jour. Animal Ecol., vol. 26, no. 1, pp. 176-196.

MOORE, H. B. 1933. Change of orientation of a barnacle after metamorphosis. Nature, vol. 132, pp. 969-970.

NEWMAN, W. A. 1967. On physiology and behavior of estuarine barnacles. Proc. Sympos. Crustacea, Mar. Biol. Assoc. India, pt. 3, pp. 1038-1066.

UTINOMI, H. 1966. Recent immigration of two foreign barnacles in Japanese waters. Proc. Japanese Soc. Syst. Zool., vol. 2, pp. 36-39.

Department of Biological Sciences, Mississippi State College for Women, Columbus, Mississippi 39701; Department of Paleontology, Natural History Museum, P. O. Box 1390, Balboa Park, San Diego, California 92112.

Synopsis of the species of *Trachurus* (Pisces, Carangidae)

Frederick H. Berry and Linda Cohen

Trachurus is one of three closely related genera (with *Decapterus* and *Selar*) of the carangid subfamily Caranginae. The genus includes 13 species, one of which is described herein as new. It occurs in most of the neritic and inner oceanic areas of all tropical and temperate marine waters. Several species are of commercial importance.

The genus and its species are diagnosed, and an analysis of morphological variation in certain characters is given for the single western Atlantic representative, *Trachurus lathami*. The distribution of the species is shown in Fig. 1.

Methods and Materials

Methods and terminology follow Berry (1968, 1969). Major characters used in distinguishing the 13 species are the position of termination of the dorsal accessory lateral line beneath the dorsal fin, numbers of gillrakers on the lateral side of the first gill arch, numbers of scales and scutes in the lateral line, and relative heights of scales in the curved lateral line and scutes in the straight lateral

TABLE 1
Frequency distributions of numbers of dorsal softrays in *Trachurus*

Species	28	29	30	31	32	33	34	35	36	37	Mean
lathami	5	9	33	45	23	6	1				30.8
mediterraneus		5	4	8	4	2	–	1			30.9
picturatus			1	1	4	6	5	2			33.0
trecae		5	4	1	2	1					30.2
trachurus		3	9	5	2	5					30.9
capensis			1	1	1	2	–	–	–	1	32.7
margaretae		2	2								29.5
indicus		1	–	4	3	1					31.4
mccullochi		1	3	5	7	1					31.2
declivis				1	1	1	–	1			32.7
japonicus	1	–	3	6	2						30.7
symmetricus				6	8	4	3	4			32.6
murphyi			1	1	2	2	2	5	1		33.6

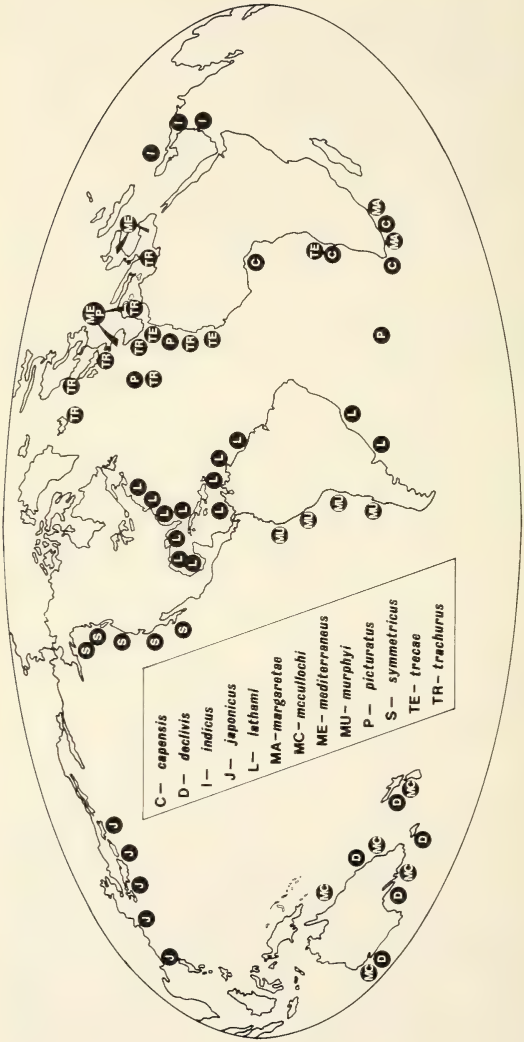


Fig. 1. Geographic distribution of the species of *Trachurus*.

line. Other useful distinguishing characters are pectoral fin length, eye diameter, and body depth.

Frequency distributions of numbers of dorsal and anal softrays are given in Tables 1-2, of gillrakers in Tables 3-5, and of lateral-line scales and scutes in Tables 6-8. Relative sizes of lateral-line scales and scutes are given in Table 9. The species can be identified by the following dichotomous key.

A list of specimens of *Trachurus* examined is given at the end of

TABLE 2
Frequency distributions of numbers of anal softrays in *Trachurus*

Species	24	25	26	27	28	29	30	31	Mean
lathami	2	4	9	38	41	22	5		27.6
mediterraneus			5	7	6	1			27.2
picturatus				3	4	7	4		28.7
trecae		2	3	4	1	1			26.6
trachurus	1	1	5	9	4	4			27.1
capensis				1	2	1	2		28.7
margaretae		2	2						25.5
indicus	1	–	–	3	4	1			27.3
mccullochi		1	1	1	8	7	1		28.2
declivis					2	–	2		29.0
japonicus				3	6	4			28.1
symmetricus			2	5	8	7	2		28.1
murphyi				2	3	5	3	1	28.9

TABLE 3
Frequency distributions of numbers of upper limb gillrakers in *Trachurus*

Species	12	13	14	15	16	17	18	19	20	Mean
lathami	2	37	49	23	4					13.9
mediterraneus		3	8	4	2	2				14.6
picturatus			1	6	4	2				15.5
trecae			1	2	10					15.7
trachurus				5	9	6	2			16.2
capensis					1	–	1	1	3	18.8
margaretae		1	2	2	1					14.5
indicus					6	2	1			16.4
mccullochi				8	7	3	1			15.8
declivis			1	1	2					15.3
japonicus			2	8	3					14.1
symmetricus			1	10	8	2	2			15.7
murphyi				1	6	5	1			16.5

TABLE 4

Frequency distributions of numbers of lower limb gillrakers in *Trachurus*

Species	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	Mean
lathami	1	5	27	37	16	20	7	2	1								36.4
mediterraneus				2	1	7	6	3	4								38.8
picturatus									7	3	2	1					41.8
trecae							1	5	2	–	3	–	2				41.5
trachurus									2	2	1	4	3	7	3	1	44.8
capensis											(A: range 49-56)						51.5
margaretae							2	–	1	2	1						41.0
indicus										4	2	2	–	–	1		43.4
mccullochi					1	1	–	1	7	5	4						41.3
declivis						1	2	1									39.0
japonicus						4	5	2	1	1							39.2
symmetricus						2	3	7	8	1	2						40.4
murphyi										2	2	3	5				43.9

A: 49(1), 50(3), 54(1), 56(1).

TABLE 5

Frequency distributions of sum of numbers of upper and lower limb gillrakers of *Trachurus*

Species	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	Mean
lathami	3	3	15	19	30	18	12	10	6												50.2
mediterraneus					3	–	4	2	4	5	–	1	2	1							54.0
picturatus										3	3	–	2	3	1						57.2
trecae									1	2	4	1	–	3	–	2					57.2
trachurus											1	2	–	2	3	5	4	2	2	2	61.1
capensis																(A: range 66-76)					70.3
margaretae							1	1	–	–	1	2	1								55.5
indicus													3	3	1	1	–	–	–	1	59.6
mccullochi								1	1	1	2	6	5	2	–	1					57.1
declivis								1	1	2											54.3
japonicus						1	2	4	4	1	1										53.6
symmetricus									2	8	4	7	–	2							56.0
murphyi													1	2	3	4	1	1			60.4

A: 66(1), 68(1), 69(2), 74(1), 76(1).

TABLE 6
Frequency distributions of the numbers of scales and scutes in the curved lateral line of *Trachurus*

Species	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	Mean
lathami	1	–	2	3	14	16	15	20	14	7	2	2							37.2
mediterraneus									2	2	2	–	3	3	6	5	–	1	43.7
picturatus										(A: range 52-58)									55.6
trecae						1	1	2	5	2	–	1	1						39.2
trachurus			1	–	6	5	2	6	1	3									36.8
capensis				1	1	1	1	–	–	1	–	–	–	–	1				37.8
margaretae			1	1	1	3													35.0
indicus							4	3	1	–	1								38.0
mccullochi				1	2	7	5	2	1										36.4
declivis										1	–	1	2						42.0
japonicus						2	5	3	3										37.5
symmetricus										(B: range 46-56)									52.4
murphyi										(C: range 51-56)									53.0

A: 52(1), 54(5), 55(2), 56(3), 57(6), 58(1).
B: 46(1), 48(1), 49(1), 50(1), 51(2), 52(4), 53(3), 54(1), 55(4), 56(2).
C: 51(1), 52(7), 53(1), 55(1), 56(2).

TABLE 7

Frequency distribution of the numbers of scutes in the straight lateral line of *Trachurus*

Species	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	Mean
lathami		4	8	16	26	21	15	6	2														35.3
mediterraneus					1	–	5	3	3	3	1	3	3	1									39.6
picturatus									1	2	3	2	5	1	3	1							43.8
trecae			3	3	5	4	1	1															35.0
trachurus	2	2	6	7	6	1																	33.7
capensis				2	1	–	2	–	1														36.0
margaretae						1	3	1	1														37.3
indicus			1	–	–	4	3	–	–	–	1												36.6
mccullochi				1	5	5	5	2	1														36.3
declivis									2	1	1												39.8
japonicus	1	1	1	5	4	1																	34.0
symmetricus										1	–	–	1	1	1	1	–	5	3	2	2	1	47.7
murphyi											1	3	–	1	2	3	2	–	–	1			44.8

this paper. The institutions in which they are preserved are given in the section on acknowledgments.

Trachurus Rafinesque, 1810

Trachurus Rafinesque, 1810, p. 41 (type species ? *Trachurus suareus* Risso *in* Cuvier and Valenciennes, 1833=*Trachurus picturatus* Bowdich, 1825).
Brachialepes Fowler, 1938, p. 46 (type species *Selar tabulae* Barnard, 1927 =*Trachurus capensis* (Castelnau, 1861)).
Suareus Dardignac and Vincent *in* Furnestin et al., 1958, p. 444 (type species *Suareus furnestini* Dardignac and Vincent, 1958 = ? *Trachurus mediterraneus* Steindachner, 1868).

Diagnosis. A genus of Caranginae with teeth in a single row in both jaws, a narrow longitudinal band of teeth on tongue and narrow band on each palatine, and vomer with a narrow anchor-shaped arrangement of teeth. Scales in anterior (curved) part of lateral line enlarged and almost scutelike. Dorsal accessory lateral line extending posteriad to below middle of first dorsal fin or beyond. First two anal spines subequal or the first one usually the longer. Low scaled sheath along bases of dorsal and anal softrays; scales on head extending anteriad above eyes, largely covering all opercular bones, suborbital area, and on expanded portion of maxillae; scales on membranes between anterior three or four rays of second dorsal and second anal fins, and scales on membranes between most rays of pectoral, pelvic, and caudal fins. A slight furrow on dorsal edge of cleithral ridge, but no papillae. Anterior lobes of soft dorsal and anal fins relatively low. Last softray of dorsal and anal fins becoming displaced from rest of fin with growth in some species, but not forming a detached finlet. First dorsal fin with eight spines. Second dorsal fin with one spine and 28-37 softrays. Anal fin with two spines followed by one spine and 24-31 softrays. Gillrakers on upper limb 12-20, on lower limb 33-56. Lateral line scales and scutes 66-107. Branchiostegal rays, seven. Vertebrae 10+14.

Synonymy. The type species of *Trachurus* is uncertain, although most authors have cited it as *T. saurus* Rafinesque (=*T. trachurus* Linneaus) (see Jordan, 1917, p. 79). The genus was established by Rafinesque (1810, p. 41), who included the three species *Trachurus Aliciolus, Trachurus Imperialis* (with *Trachurus Saurus* listed under that account), and *Trachurus Aguilus*, described on page 42 as new.

Based on his account and his plate 11, only *T. imperialis* appears to belong to the Caranginae, and it has generally been regarded as a junior synonym of *Caranx dentex* (Bloch and Schneider 1801). Later, Rafinesque (1815, pp. 20-21) listed five species under *Trachurus.* The first was "*Trachurus saurus* Raf. (*Caraux trachurus* Lac. *Scomber trachurus* Linn.)." *T. saurus* Rafinesque 1810 in a *nomen nudum.* If *T. saurus* Rafinesque 1815 were regarded as a replacement name for *T. trachurus* (Linnaeus 1758), this would invalidate the tautonym and first named species of the genus (as we now know it). *T. suareus* Risso 1833, was documented by Cuvier in Cuvier and Valenciennes (1833, p. 33) and examination of the holotype (by Berry) discloses that it is a junior synoym of *T. picturatus* (Bowdich, 1825).

Several genera of Carangidae, including the type genus *Caranx* and *Trachurus,* may be regarded as technically invalid, but they have entrenched usage and should be conserved. When the generic limits and the nominal species are all finally analyzed, an appeal for this conservation should be made.

Key to the Species of *Trachurus*

1. Dorsal accessory lateral line extending posteriad to beyond 5th dorsal softray 2
   Dorsal accessory lateral line terminating anterior to 5th dorsal softray 5
2. Dorsal accessory lateral line terminating below 19th-32nd dorsal softray 3
   Dorsal accessory lateral line terminating below 6th to 10th dorsal softray 4
3. Lower limb gillrakers 41-48 (Northeastern Atlantic) .... *trachurus*
   Lower limb gillrakers 49-56 (Southeastern Atlantic) .... *capensis*
4. Scales and scutes in curved lateral line 40-43 (Australia, New Zealand) .... *declivis*
   Scales and scutes in curved lateral line 52-58 (Eastern Atlantic) *picturatus*
5. Dorsal accessory lateral line terminating below first 3 to 6 spines of dorsal fin (Eastern Atlantic) .... *trecae*
   Dorsal accessory lateral line terminating below 7th dorsal spine to 4th dorsal softray 6
6. Total scales and scutes in lateral line 68-89 8
   Total scales and scutes in lateral line 93-107 7
7. Scales in curved lateral line low, 2.3-3.1 per cent SL (Northeastern Pacific) .... *symmetricus*
   Scales in curved lateral line high, 4.6-5.6 percent SL (Southeastern Pacific) .... *murphyi*

8. Scutes in straight lateral line high, 6.8-7.5 per cent SL *and* scales in curved part less high than scutes in straight part, 1.30-1.48 ratio (South Africa) .... *margaretae*
   Scutes in straight lateral line low, 4.5-6.8 per cent SL, *or* scales in curved part higher than scutes in straight part........ 9
9. Pectoral fin short, less than 27 per cent SL at sizes of 100 mm SL and larger (Eastern Atlantic)........ *mediterraneus*
   Pectoral fin more than 27 per cent SL 10
10. Eye small at sizes greater than 165 mm SL, diameter 7.4 per cent SL or less (Australia, New Zealand) .... *mccullochi*
    Eye 7.8 per cent SL or larger 11
11. Lower gillrakers 42-47; *and* scutes in straight lateral line not high, 4.8-5.4 per cent SL (Arabian Sea, Persian Gulf)........ *indicus*
    Lower gillrakers 33-40; *or* scutes in straight lateral line higher, 6.1-7.4 per cent SL 12
12. Height of scales in curved part and scutes in straight part of lateral line greater, 5.5-7.0 per cent SL curved and 6.1-7.4 per cent SL straight (Japan and China) .... *japonicus*
    Height of scales in curved part and scutes in straight part of lateral line less, 4.2-6.2 percent SL curved, 5.0-6.8 per cent SL straight (Western Atlantic) .... *lathami*

Trachurus mediterraneus (Steindachner)

Caranx trachurus mediterraneus Steindachner, 1868, p. 393 (type locality Mediterranean Sea).

Trachurus mediterraneus ponticus Aleev, 1956, p. 178 (type locality Black Sea).

?*Suareus furnestini* Dardignac and Vincent in Furnestin et al, 1958, p. 445 (type locality Morocco).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between eighth spine and third softray. Scales and scutes in curved part of lateral line 39-48. Total scales and scutes in lateral line 75-89. Height of scales or scutes in curved lateral line, 3.3-4.3 per cent SL; in straight lateral line 4.5-5.3 per cent SL. Ratio of height of straight to curved lateral-line scales 1.15-1.47. Total gillrakers, 50-59. Pectoral length 24.5-26.5 per cent SL above 125 mm SL. Body depth 22.0-24.2 per cent SL. Eye diameter 8.2-8.8 per cent SL.

Remarks. Conflicting opinions exist about the species and subspecies of *Trachurus* and their proper scientific names in the northeastern Atlantic-Mediterranean-Black Sea area (see for example Tortonese 1952, Aleev 1956, Blanc and Bauchot 1961, and Slasten-

enko 1965). We accept the opinion of Aleev (1956, p. 183) that *Scomber lacerta* Pallas 1811 is a *nomen dubium.* Based on the limited amount of material available in this study and our attempt to ameliorate various pronouncements in the literature, we tentatively recognize three species in the above area: *trachurus, picturatus,* and *mediterraneus.*

Relationships. T. mediterraneus is most similar morphologically to *lathami* (discussed under that species) and to *indicus.* Compared to *mediterraneus, indicus* has a longer pectoral fin (27.2-32.5 per cent SL vs. 24.5-26.7 per cent SL) and a greater body depth (26.1-28.2 per cent SL vs. 22.0-24.2 per cent SL), but the differences in gross appearance of the two species suggest that they are not closely related phylogenetically.

Distribution. Northeastern Atlantic from the Bay of Biscay to the Straights of Gibraltar and the Mediterranean, Black, Marmana, and Azov Seas (Aleev, 1956); to Casablanca (if *furnestini* is a valid synonym).

Trachurus picturatus Bowdich

Seriola picturata Bowdich, 1825, p. 123, fig. 27 (type locality Madeira).
Caranx suareus Risso in Cuvier and Valenciennes, 1833, p. 33 (type locality Mediterranean; holotype 435 mm SL, MNHN B.869).
Trachurus melanosaurus Cocco, 1839, p. 1.
Caranx cuvieri Lowe, 1841, p. 183 (type locality Madeira).
Trachurus fallax Capello, 1868, p. 318 (type locality Portugal).
Trachurus rissoi Giglioli, 1880, p. 27.
Decapterus longimanus Norman, 1935, p. 255, fig. 1 (type locality Tristan de Cunha; holotype 412 mm SL, BMNH 1935.5.2.3).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between 6th and 10th softrays. Scales and scutes in curved part of lateral line 52-58. Total scales and scutes in lateral line 93-100. Height of scales or scutes in curved lateral line, 3.6-5.1 per cent SL; in straight lateral line 3.9-5.4 per cent SL. Ratio of height of straight to curved lateral-line scales 1.03-1.21. Total gillrakers 55-60. Pectoral length 23.4-29.3 per cent SL. Body depth 18.8-22.2 per cent SL. Eye diameter 7.1-9.7 per cent SL.

Remarks. We have not investigated the synonymy of this species, but follow the account of Tortonese (1950), with the addition of two synonyms. A direct comparison of an adequate series

of specimens might reveal differences between those from the North Atlantic and those from the South Atlantic.

Arrangement of dentition is similar in all species of the genus, but variation was noted in three of nine specimens of *T. picturatus* from Maderia; two had an enlarged head of the vomer (MMF 3432 and 3859), and one had an expanded vomerine shaft (MMF 21674).

Relationships. The very extended dorsal accessory lateral line and the high number of scales and scutes in the lateral line differentiate *picturatus* from all other *Trachurus*. *T. picturatus* appears most closely related morphologically to *murphyi* and *declivis*. Suspected hybridization is discussed under the account of *T. trachurus*.

Distribution. Northeast Atlantic in the Bay of Biscay, from the Azores to the Canary Islands, and in the Mediterranean Sea (Aleev, 1956); southeastern Atlantic at Tristan de Cunha.

Trachurus trecae Cadenat

Trachurus trecae Cadenat, 1949, p. 668 (type locality Mauritania; two syntypes, MNHN 50-71, 158-178 mm SL).

Diagnosis. Dorsal accessory lateral line normally extending posteriad beneath dorsal fin to between the first and sixth spines. Scales and scutes in curved part of lateral line 36-43. Total scales and scutes in lateral line 71-78. Height of scales or scutes in curved lateral line, 2.1-2.9 per cent SL; in straight lateral line, 3.2-4.0 per cent SL. Ratio of height of straight to curved lateral-line scales 1.39-1.61. Total gillrakers 54-61. Pectoral length 28.3-30.3 per cent SL at sizes larger than 125 mm SL. Body depth 25.0-27.1 per cent SL. Eye diameter 8.4-9.4 per cent SL.

Remarks. The dorsal accessory lateral line is shorter and ends farther forward in *trecae* than in other *Trachurus*. On the basis of our definition of the termination point (from beneath the anterior origin of a dorsal fin spine to the origin of the succeeding spine posteriad), 656 specimens of *trecae* from throughout most of its range had the following frequency distribution of accessory lateral-line terminations:

spine position	0	1	2	3	4	5	6
number of specimens	3	8	36	192	379	35	3.

In the three specimens (from three separate collections) with the zero position, the accessory lateral line ended well anterior to the

dorsal fin. Tabulations were taken on the left side of each fish. The termination on the right was usually symmetrical, but varied slightly in some specimens; two specimens from one collection lacked the line on the right side.

Distribution. Mauritania to Angola.

Trachurus trachurus (Linnaeus)

Scomber trachurus Linnaeus, 1758, p. 298 (type locality Mediterranean).
Caranx semispinosus Nilsson, 1832, p. 84 (type locality Norwegian Sea).
Trachurus europaeus Gronovius, 1854, p. 125 (type locality seas of Europe: holotype BMNH 1853.11.12.95, length 189 mm).
Trachurus linnaei Malm, 1877, p. 421 (type locality Bohuslän, Sweden).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between 23rd and 31st softrays. Scales and scutes in curved lateral line 33-40. Total scales and scutes in lateral line 66-75. Height of scales or scutes in curved part of lateral line, 6.3-8.2 per cent SL; in straight lateral line, 6.5-7.9 per cent SL. Ratio of height of straight to curved lateral line scale 1.05-1.23. Total gillrakers 56-65. Pectoral length 26.6-28.2 per cent SL at sizes larger than 150 mm SL. Body depth 21.6-24.1 per cent SL. Eye diameter 8.2-8.9 per cent SL.

Remarks. Three of 23 specimens of *Trachurus* examined from Madeira were intermediate in appearance and in certain characters between the two species, *trachurus* and *picturatus*, known to occur there. They may represent a distinct species, but we consider them hybrids, especially because we have so few specimens from a single oceanic location. The following text-table indicates the intermediacy of the specimens we presume to be hybrids on the basis of ranges of four characters; number of scales and scutes in curved lateral line (A), number of scutes in straight lateral line (B), numbered softray under which the accessory lateral line ends (C), and relative height of scales in the curved lateral line as percent SL (D):

	A	B	C	D
picturatus	52-58	39-46	6-8	3.6-5.1
hybrids	44-46	35-38	15-23	5.8-6.5
trachurus	35-40	31-36	23-32	6.3-8.2

One hybrid (TABL 106537) has nine spines in the first dorsal fin and eight associated interneurals. Eight first dorsal spines and seven associated interneurals is the maximum number normally found in most species of Caranginae. In examining thousands of specimens of most species of the subfamily we found only one other specimen with nine first dorsal spines, *Uraspis secunda* (Poey), MCZ 16073.

One specimen from Madeira (256 mm SL, MMF 3409), with a pug-nosed condition, had an extremely distorted and expanded shaft of the vomer.

Because of our relatively small sample of specimens of *trachurus*, we have not been able to analyze the possibility of subspecies in this species. A clinal relationship in three meristic characters was evident. A comparison of six specimens from Scandinavia, 11 from the Mediterranean, and seven from Madeira, revealed mean increases from 32.5-33.7-34.9, respectively, in scutes in the straight lateral line, increases from 57.6-61.4-63.1 in total gillrakers, and increases from 56.0-57.8-59.5 in sums of dorsal and anal softrays. A similar trend was seen in specimens of the closely related *capensis* from Nigeria and South Africa in means of total gillrakers but not in other characters.

Relationships. The eastern Atlantic *trachurus* and *capensis* are the only species of the genus with the accessory lateral line extending so far posteriad on the body (to beneath the 19th dorsal softray or beyond). *T. trachurus* has fewer total gillrakers (56-65 vs. 66-76) and higher scales and scutes in the lateral line (6.3-8.2 per cent SL vs. 4.8-5.2 per cent SL in the curved lateral line: 6.5-7.9 per cent SL vs. 5.5-5.9 per cent SL in the straight lateral line).

Distribution. Northeast Atlantic from Iceland to the Cape Verde Islands and Mediterranean Sea eastward to the Bosporus (Aleev, 1956).

Trachurus capensis Castelnau

Trachurus capensis Castelnau, 1861, p. 43 (type locality South Africa).
Selar tabulae Barnard, 1927, p. 538 (type locality Table Bay, South Africa; holotype in South African Museum, length 410 mm).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between 19th and 27th softrays. Scales and scutes

in curved lateral line 34-45. Total scales and scutes in lateral line 71-79. Height of scales or scutes in curved part of lateral line, 4.8-5.2 per cent SL; in straight lateral line, 5.5-5.9 per cent SL. Ratio of height of straight to curved lateral line scales 1.05-1.23. Total gillrakers 66-76. Pectoral length 27.7-29.7 per cent SL, above 175 mm SL. Body depth 23.2-27.5 per cent SL. Eye diameter 7.9-8.5 per cent SL.

Remarks. Castelnau's name of *capensis* is accepted for this species following the opinion of Nichols (1920, 1935). Margaret M. Smith (personal communication) informed us that the type of Barnard's *tabulae* had been examined by J. L. B. Smith, who found that it was a *Trachurus*. The high counts of dorsal softrays (38), and lower limb gillrakers (55) given for *tabulae* by Barnard (1927, p. 538) cause us to synonymize these two nominal species.

Relationships. The relation to *trachurus* and differentiation of *capensis* and *trachurus* are discussed under that species.

Distribution. Imperfectly known. Specimens examined by us from Nigeria and South Africa. Reported westward to Delagoa Bay by Smith (1961, p. 213). Apparently reported from Angola (as *T. trachurus*) by Poll (1954, p. 117).

Trachurus margaretae, new species (Fig. 2)

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between eight and ninth spines. Scales and scutes in curved part of lateral line 33-36. Total scales and scutes in lateral line 69-73. Height of scales or scutes in curved lateral line, 4.7-6.0 per cent SL; in straight lateral line, 6.5-7.5 per cent SL. Ratio of height of straight to curved lateral line scales 1.09-1.48. Total gillrakers 52-58. Pectoral length 30.9-32.0 per cent SL at 157-154 mm SL, 25.9 per cent SL from 89.5-123 mm SL. Body depth 23.2-26.1 per cent SL. Eye diameter 8.5-9.1 per cent SL.

Material. Holotype, USNM 93661, 123 mm SL, from Durban, South Africa. Paratypes: USNM 153510, 3 specimens, 68.5-89.5 mm SL, from Knysna Estuary, South Africa; SAM 16734, 174 mm SL, South Africa; TABL 107267, 157 mm SL, Durban, South Africa.

Description of the holotype. Standard length 123 mm. Caudal fin broken. Accessory lateral line ending under ninth dorsal spine. Dorsal fin VIII, I-29. Anal fin II, I-25. Pectoral fins I-20 (both). Pelvic fins I-5 (both). Gillrakers 16+41 (right side), 15 over

Fig. 2. *Trachurus margaretae* n. sp., holotype, Durban, South Africa, 123 mm SL (USNM 93661).

hypobranchial including one anterior rudiment. Gill filaments on lateral side of first arch 33+81 (right). Pseudobranch filaments 21 (left). Branchiostegal rays 3+4 (both). Lateral line, curved (right) 30 scales and 4 scutes; curved (left), 31 scales and 3 scutes; straight (right), 38 scutes and 3 scales; straight (left), 39 scutes and 3 scales. Vertebrae 10+14. Measurements in per cent SL: head length 28.6; eye diameter 8.5; snout length 8.0; postorbital head length 11.5; upper jaw length 10.7; maxillary depth 3.7; body depth, 24.2 maximum vertical, 25.0 from first dorsal spine to pelvic insertion, 25.0 from ninth dorsal spine to first anal spine; pectoral

length 25.9; pelvic length 16.2; longest dorsal spine 15.5 (3rd); longest dorsal softray ca. 14.0 (1st); anal spine lengths, 6.4 (1st), 5.8 (2nd); longest anal softray ca. 13.1 (1st); maximum height of scales or scutes in curved lateral line 5.8, in straight lateral line, 7.5. Ratio of height of straight to curved lateral line scales 1.29. Ratio of lengths of curved to straight lateral line 0.70 (both).

Remarks. Two species occur in South African waters and two available names exist for *Trachurus* from that area. The later named species (*tabulae* of Barnard) is not this new species, especially in view of the high lower limb gillraker count (55) given in the original description. The first named species (*capensis* of Castelnau) has such an imprecise description (and we do not know if a type specimen exists) that we relate it to the more common species from South Africa, as has been done previously. We therefore describe the rarer *T. margaretae* as new.

Distribution. Currently known only from Durban and Knysna Estuary, South Africa.

Name. Named in honor of Margaret Mary Smith, Director, J. L. B. Smith Institute of Ichthyology.

Trachurus indicus Necrassov

Trachurus mediterraneus indicus Necrassov, 1966, p. 141 (type locality off Oman, Arabian Sea).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between seventh and eighth spines. Scales and scutes in curved part of lateral line 37-41. Total scales and scutes in lateral line 72-79. Height of scales or scutes in lateral line, 3.6-5.1 per cent SL curved, 4.8-5.4 per cent SL straight. Ratio of height of straight to curved lateral line scales 1.06-1.34. Total gillrakers 58-65. Pectoral length 29.9-32.5 per cent SL, at sizes larger than 168 mm SL. Body depth 26.1-28.2 per cent SL. Eye diameter 8.5-10.1 per cent SL.

Remarks. In one specimen (TABL 105998) the accessory lateral line is abnormally bent near its termination on each side of the body; it ends abnormally short under the first spine on the right side and under the fourth spine on the left.

Relationships. Discussed under the account of *mediterraneus.*

Distribution. Gulf of Oman and Persian Gulf.

Trachurus mccullochi Nichols

Trachurus mccullochi Nichols, 1920, p. 479 (type locality Australian seas; description based on account of McCulloch, 1915).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between eighth spine and second dorsal softray. Scales and scutes in curved part of lateral line 34-39. Total scales and scutes in lateral line 71-77. Height of scales or scutes in curved lateral line, 4.8-6.9 per cent SL; in straight lateral line, 5.0-7.3 per cent SL. Ratio of height of straight to curved lateral line scales 0.98-1.18. Total gillrakers 53-61. Pectoral length 27.2-29.7 per cent SL at sizes larger than 110 mm SL. Body depth 21.3-26.3 per cent SL. Eye diameter 8.0-9.7 per cent SL on specimens 78-160 mm SL, 6.4-7.2 on three specimens 166-252 mm SL.

Remarks. Our material is in relatively poor condition and insufficient for a thorough definition of this species. The three largest specimens are certainly distinctive. The 16 smaller specimens (which have relatively larger eyes) are assigned to this species, but they are morphologically more similar to *japonicus* of the northwest Pacific.

Relationships. T. mccullochi may be a southern hemisphere cognate of *japonicus*, but it has a larger eye than that species at sizes larger than about 220 mm SL. It is differentiated from *lathami* under the account of that species.

Distribution. Australia and New Zealand.

Trachurus declivis (Jenyns)

Caranx declivis Jenyns 1841, p. 68 (type locality King George's Sound, New Holland, holotype BMNH 1917.7.14.30, 163 mm SL).

Trachurus novae zealandiae Richardson, 1842, p. 21 (type locality New Zealand; description based on the vernacular "Le saurel de la Nouvelle-Zélande" by Cuvier in Cuvier and Valenciennes, 1833, p. 26).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between sixth to tenth softrays. Scales and scutes in curved lateral line 40-43. Total scales and scutes in lateral line 81-82. Height of scales or scutes in curved part of lateral line, 7.5-8.0 per cent SL; in straight lateral line, 6.8-7.4 per cent SL. Ratio of height of straight to curved lateral-line scales 0.85-1.00. Total

gillrakers 53-55. Pectoral length ca. 25.0-28.0 per cent SL. Body depth 22.0-23.1 per cent SL. Eye diameter ca. 7.0-8.3 per cent SL.

Remarks. Examinatin of the holotype (by Berry) confirms the identity of this species; the dorsal accessory lateral line is difficult to discern in the somewhat damaged specimen but apparently ends under the 10th dorsal softray on the left side and under the 9th on the right.

Distribution. Australia and New Zealand.

Trachurus japonicus (Temminck and Schlegel)

Caranx trachurus japonicus Temminck and Schlegel, 1844, p. 109 (type locality Japan).

Trachurus argenteus Wakiya, 1924, p. 145 (type locality Amakusa, Japan; paratype FMNH 59421, 285 mm SL).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between ninth spine and second softray. Scales and scutes in curved part of lateral line 36-39. Total scales and scutes in lateral line 69-73. Height of scales or scutes in lateral line, 5.5-7.0 per cent SL curved, 6.1-7.4 per cent SL straight. Ratio of height of straight to curved lateral line scales 0.98-1.24. Total gillrakers 51-56. Pectoral length 28.9-30.9 per cent SL at 227 mm SL and larger. Body depth 24.6-26.6 per cent SL at 227 mm SL and larger. Eye diameter 7.8-8.3 per cent SL at 227 mm and larger.

Relationships. T. japonicus appears to be closest morphologically to the most geographically distant species, *lathami,* but the similarity may represent parallel evolution of morphological characters in similar ecotypes. It is also similar to *mccullochi.* See under the accounts of those two species.

Distribution. Japan and China.

Trachurus symmetricus (Ayres)

Caranx symmetricus Ayres, 1855, p. 62 (type locality San Francisco Bay, California).

Decapterus polyaspis Walford and Myers, 1944, p. 45 (type locality off Reedsport, Oregon; holotype SU 14375, 380 mm SL).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between eighth spine and second softray. Scales

and scutes in curved part of lateral line 46-56. Total scales and scutes in lateral line 93-107. Height of scales or scutes in curved lateral line, 2.3-3.1 per cent SL; in straight lateral line, 3.9-4.4 per cent SL. Ratio of height of straight to curved lateral line scales 1.29-1.73. Total gillrakers 54-59. Pectoral length 24.4-25.9 per cent SL above 145 mm SL. Body depth 19.2-21.5 per cent SL. Eye diameter 7.6-8.6 per cent SL.

Relationships. T. symmetricus and *murphyi* appear to be an antitropical species pair; they may be separated by the smaller scales and scutes in the lateral line of *symmetricus* and its fewer average number of gillrakers on the lower limb.

Distribution. Alaska to southern Baja California, Mexico, and the Gulf of California.

Trachurus murphyi Nichols

Trachurus murphyi Nichols, 1920, p. 479 (type locality Central Island of the Chimchas, Peru; putative neotype AMNH 7259, 296 mm).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between first and fifth softrays. Scales and scutes in curved part of lateral line 52-56. Total scales and scutes in lateral line 94-106. Height of scales or scutes in lateral line, 4.6-5.6 per cent SL curved, 4.8-5.7 per cent SL straight. Ratio of height of straight to curved lateral line scales 0.98-1.07. Total gillrakers 58-63. Pectoral length 30.2-32.1 per cent SL at sizes larger than 180 mm SL. Body depth 20.5-24.0 per cent SL. Eye diameter 8.0-9.1 per cent SL to about 300 mm SL, decreasing to ca. 6.3 per cent SL at sizes larger than 400 mm SL.

Remarks. The type specimens of *murphyi* have been confused. Nichols (1920:478) mentioned having two specimens from Peru in the American Museum of Natural History when he described the species as new, and he listed the "type" as AMNH 7259. The AMNH catalog lists the holotype under this number and presumably the second specimen as AMNH 7260. With the assistance of C. Lavett Smith, three unlabeled or mislabeled AMNH specimens were examined by Berry; they were the only three AMNH specimens that could be regarded as types of *murphyi*. One measuring 256 mm bore a paper label with the number "7260" inside the operculum, but because that specimen appeared to be *japonicus*, it

was assigned a new number. A 295-mm specimen, with the tail broken off and no label, is *murphyi* and is associated with AMNH 7260. An unlabeled 296-mm specimen with a damaged and overgrown area of scutes on the straight lateral line of the left side fits the brief description of the species by Nichols. That specimen is assigned AMNH 7259 and is herein designated as the putative neotype of *T. murphyi* (in the sense of Whitehead, Boeseman, and Wheeler, 1966, pp. 14-15).

Relationships. T. murphyi is most closely related morphologically and geographically to *T. symmetricus,* which see. *T. murphyi* is intermediate between the seven species that have the dorsal accessory lateral line ending close to the first and second dorsal fins and *declivis* of Australia and *picturatus* of the eastern Atlantic; *murphyi* appears to be an ecotype of *picturatus* in that it has a large number of scutes in the lateral line.

Distribution. Off northern Peru to south-central Chile.

Trachurus lathami Nichols (Fig. 3)

Trachurus lathami Nichols, 1920, p. 479 (type locality Long Island, New York; holotype AMNH 7351, 96 mm SL).

Trachurus picturatus binghami Nichols, 1940, p. 2 (type locality off Mobile Bay, Alabama; holotype AMNH 15212, 73 mm SL).

Trachurus picturatus australis, Nani, 1950, p. 178 (type locality Quequén, Argentina; holotype SIMACN 4175, 188.5 mm TL).

Diagnosis. Dorsal accessory lateral line extending posteriad beneath dorsal fin to between eight spine and fourth softray. Scales and scutes in curved lateral line 31-42. Total scales and scutes in lateral line 68-77. Height of scales or scutes in curved lateral line, 4.2-6.2 per cent SL; in straight lateral line 5.0-6.8 per cent SL. Ratio of height of straight to curved lateral-line scales 1.08-1.28. Total gillrakers on lateral side of first arch 46-54. Pectoral length 26.8-32.8 per cent SL at sizes larger than 100 mm SL. Body depth 24.2-27.5 per cent SL. Eye diameter 7.8-10.0 per cent SL; 7.8-9.2 per cent SL at sizes larger than 200 mm SL.

Remarks. Many subjective species synonyms have been proliferated in certain groups of the Carangidae. Most of these are from specimens of wide-ranging species collected in diverse places by earlier workers. The reverse has been true of the genus *Trachurus,*

Fig. 3. *Trachurus lathami* Nichols, Trinidad, 266 mm SL, 12.3 inches total length (TABL 101836).

where the first-named species, *T. trachurus* (Linnaeus, 1758), which occurs only in the northeastern Atlantic, often has been uncritically assigned a world-wide distribution. During the last 40 years, *Trachurus* has been reported in the western Atlantic under the following names: *T. trachurus, T. declivis, T. lathami, T. picturatus, T. picturatus binghami, T. picturatus australis,* and two or three species have been considered to exist in the western Atlantic by several authors (as Nichols, 1940 and Nani, 1950).

No account that lists species other than *lathami* from the western Atlantic is sufficiently convincing to justify the existence of any other species than *lathami* there. We suspect that the high total lateral-line scale counts (76-87) "estimated in 8 specimens of 27 to 35 mm." from the western Atlantic by Nichols (1940) are in error. All specimens we examined from the western Atlantic represent a single species, and we presume that *lathami* is the only species of *Trachurus* that occurs in the area.

We regard the poor description of *Caranxom plumierianus* Lacépède (1802, p. 82, pl. 2), based on a drawing by Plumier from Martinique, to be a *nomen nudum.* Jordan and Evermann (1896, p. 911) suggested that it might represent a western Atlantic *Trachurus.* It might be equally well postulated that the description is a species of *Decapterus, Selar,* or *Caranx.*

Relationships. T. lathami is morphologically most similar to three other species. *T. mediterraneus* has a shorter pectoral fin (24.5-26.7 per cent SL vs. 26.8-32.8 per cent SL for *lathami,* each for specimens larger than 100 mm SL) and a less deep body (22.0-

24.2 per cent SL vs. 24.2-27.5 per cent SL). *T. mccullochi,* at sizes greater than 200 mm SL, has a smaller eye (ca. 6.4-7.2 per cent SL vs. 7.8-9.2 per cent SL for *lathami*), a more pointed head profile, and averages a lesser body depth. *T. japonicus* is the species most distant geographically and most similar morphologically to *lathami*; *japonicus* averages a slightly greater height of curved and straight lateral-line scales (Table 9).

Distribution. From the Gulf of Maine to northern Argentina. We have examined specimens from off Massachusetts, New York, North Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Mexico (Tabasco and Campeche), Colombia, Venezuela, Trinidad, Grenadines, Surinam, French Guiana, Brazil (São Paulo), and Argentina (Rio de la Plata).

VARIATION IN *Trachurus lathami*

Dorsal and anal fin spines. The dorsal fin had 8+1 spines and the anal 2+1 spines in all 115 specimens counted. The third dorsal spine is the longest, measuring about 12.8-14.9 per cent SL. The first anal spine is normally longer than the second and measures about 4.2-5.8 per cent SL at smaller sizes, decreasing to about 3.5-4.2 per cent SL at sizes larger than 200 mm SL.

Dorsal and anal softrays. The numbers of dorsal and anal softrays are positively correlated, with a mode at D31-A28 (Table 10). The number of dorsal softrays is usually three more than the number of anal softrays, and ranges from one to seven more. The individual frequency distributions are shown in Tables 1-2. The first softray of the dorsal and anal fins is usually the longest in each fin. The first dorsal softray ranges 12.2-14.5 per cent SL at smaller sizes decreasing to almost 11.5 per cent SL above 200 mm SL. The first anal softray ranges about 10.8-13.3 per cent SL.

Pectoral fins. Each pectoral fin consists of one spine at its dorsal origin and 19-20 softrays. The number of softrays is usually the same on each side of a fish, but bilateral variation does occur (15.2 per cent of 66 specimens). Seven of the ten bilaterally variable specimens had one less ray in the left fin than the right. The following frequencies of softrays were obtained: 19 both (2), 19-20 (4), 20 both (46), 20-21 (6), 21 both (8).

The pectorals are blunter at smaller sizes and the fin length is about 20-22.5 per cent SL at 19-50 mm SL. The fins become longer

TABLE 8
Frequency distributions of numbers of total curved and straight lateral line scales and scutes in *Trachurus*

Species	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	Mean
lathami			1	2	10	11	28	22	11	7	4	1													72.5
mediterraneus										1	–	–	2	1	2	–	2	4	2	–	3	2	2	1	83.2
picturatus																		(A: range 93-100)							98.1
trecae						1	2	3	1	2	1	2	1												74.3
trachurus	2	1	1	2	6	7	2	–	1	2															70.4
capensis						2	1	–	–	2	–	–	2												73.8
margaretae				1	–	–	1	4																	72.2
indicus							1	2	3	1	–	1	–	1											74.6
mccullochi						4	5	7	–	1	–	1													72.6
declivis																1	3								81.6
japonicus				1	2	3	4	2	1																71.5
symmetricus																		(B: range 93-107)							100.5
murphyi																		(C: range 94-106)							97.8

A:93(1), 96(1), 97(6), 98(2), 99(2), 100(6).
B: 93(2), 94(1), 97(1), 98(2), 100(1), 101(3), 102(3), 103(3), 104(3), 107(1).
C: 94(2), 96(1), 97(3), 98(5), 101(1), 106(1).

and pointed between about 55 and 95 mm SL, and are falcate (28.5-32.5 per cent SL) above 140 mm SL. In Fig. 4 average values are suggested, which were determined by a visual fit; 20.6 per cent SL at 20-40 mm SL, 23.7 per cent SL at 50-75 mm SL, and 30.2 per cent SL at 115-300 mm SL.

Pelvic fins. Each pelvic fin has one spine at its lateral origin and five softrays (71 specimens). Pelvic fins averaged a greater length at smaller body sizes (16-18.2 per cent SL to 100 mm SL; 14-16.2 per cent above 170 mm SL).

Gillrakers. Gillraker numbers of the upper and lower limbs of the lateral side of the first arch tend toward a positive correlation, with a mode at U14-L36 (Table 11). The individual frequency distributions are shown in Tables 3-4 and the combined counts of both limbs for individual specimens in Table 5.

TABLE 9

Relation of maximum heights of scutes in curved and straight parts of the lateral line in *Trachurus*. Shown as ranges of per cent of standard length for both straight and curved part scutes and as ranges of ratio of straight scute height divided by curved.

Species	Curved	Straight	Ratio
lathami	4.2-6.2	5.0-6.8	1.08-1.28
mediterraneus	3.3-4.3	4.5-5.3	1.15-1.47
picturatus	3.6-5.1	3.9-5.4	1.03-1.21
trecae	2.1-2.9	3.2-4.0	1.39-1.61
trachurus	6.3-8.2	6.5-7.9	0.96-1.15
capensis	4.8-5.2	5.5-5.9	1.05-1.23
margaretae	4.7-6.0	6.5-7.5	1.09-1.48
indicus	3.6-5.1	4.8-5.4	1.06-1.34
mccullochi	4.8-6.9	5.0-7.3	0.98-1.18
declivis	7.5-8.0	6.8-7.4	0.85-1.00
japonicus	5.5-7.0	6.1-7.4	0.98-1.24
symmetricus	2.3-3.1	3.9-4.4	1.29-1.73
murphyi	4.6-5.6	4.8-5.7	0.98-1.07

A single rudimentary gillraker on the anterior end of either the upper or lower limb of the lateral side of the first arch was found in 25.4 per cent of 126 specimens; 5 had the rudiment on the upper limb and 27 had the rudiment on the lower limb.

Numbers of gillrakers over the hypobranchial portion of the lower limb for 118 specimens ranged 11 (10), 12 (47), 13 (40), 14

TABLE 10

Frequency distributions of numbers of dorsal and anal softrays, correlated for individual specimens of *Trachurus lathami*

Anal softrays	28	29	30	31	32	33	34
30			1	1	2	1	
29			1	7	12	2	1
28			12	19	6	2	
27	1	6	10	13	3		
26	1	2	5	2			
25	2			2			
24			1	1			

(17), 15 (3), 16 (1). The ceratobranchial counts ranged 21 (3), 22 (4), 23 (46), 24 (38), 25 (22), 26 (5). Apparently there is only slight positive correlation between hypobranchial and ceratobranchial numbers of gillrakers. A dual mode for combined counts occurs at H12-C23 and H13-C23.

Gillraker numbers apparently do not change as body length increases between 60-305 mm SL.

Lateral line. The point of junction of the curved (anterior) part of the lateral line with the straight (posterior) part is usually below the eighth or ninth dorsal softray, ranging from the sixth to the tenth softray. The junction is often bilaterally asymmetrical, ending from 1-4 softrays farther forward on one side than the other (this variation seems to be random, right or left).

The chord of the curved part of the lateral line (33-38.5 per cent SL) is shorter than the length of the straight part (39-45.5 per cent SL), and the lateral-line ratio ranges about 1.1-1.35. A slight bilateral variation in the lengths of each part is apparently random.

Scales (non-scutellated) in the curved part of the lateral line range 29-39 with the following frequencies: 29 (3), 30 (2), 31 (13), 32 (11), 33 (17), 34 (19), 35 (20), 36 (12), 37 (3), 38 (0), 39 (1); counts from both sides of 50 specimens showed 17 with the same number on each side, 21 with one more scale on one side, 11 with 2 more scales, and 1 with 3 more scales. Bilateral variation was apparently random, right or left. The posterior end of the curved lateral line has zero to nine scutes (pointed) with the following frequencies: 0 (1), 1 (6), 2 (11), 3 (28), 4 (30), 5 (14), 6 (7),

TABLE 11

Frequency distributions of numbers of upper and lower limb gillrakers, correlated for individual specimens of *Trachurus lathami*

	Lower limb gillrakers								
Upper limb	33	34	35	36	37	38	39	40	41
16				1	1	2			
15		6	6	6	2	7	3		
14			9	20	10	7	2	2	
13	1	3	15	9	5	4	1		1
12		2							

7 (0), 8 (1), 9 (1); counts from both sides of 51 specimens showed 20 with the same number on each side, 22 with one more scute on one side, 8 with 2 more scutes, and 1 with 3 more scutes, and the variation was apparently bilaterally random. Frequency distribution of the sum of scales and scutes in the curved lateral line is shown in Table 6. The relation between the numbers of scales and scutes in the curved lateral line for individual fish appears to be inversely correlated; higher scale counts are associated with lower scute counts.

Frequency distribution of the numbers of scutes in the straight lateral line is shown in Table 7. Counts of straight lateral line scutes of 58 specimens showed 18 with the same number on each side, 26 with one more scute on one side, 8 with 2 more, 4 with 3 more, 1 with 4 more, and 1 with 5 more. This bilateral variation is apparently random; 19 specimens have more scutes on the left side and 21 specimens have more scutes on the right side.

The pored scales of the lateral line terminate over the median caudal fin rays. The one to four scales (lacking points and thickness of scutes), which form the end of the lateral line [1 (12), 2 (26), 3 (24), 4 (6)], are frequently lost in preserved specimens and thus were not included in the counts of straight lateral line of the total lateral line.

Frequency distribution of the total number of scales and scutes in both parts of the lateral line (excluding the 1-4 terminal scales) are shown in Table 8. Bilateral variation (apparently random) occurs in this total count; in 57 specimens 11 have the same count on

TABLE 12

Frequency distributions of character index sums for dorsal-anal softrays, upper-lower limb gillrakers, and scales-scutes in the lateral line for *Trachurus lathami*, grouped by geographic area.

	Dorsal-anal softrays											
	53	54	55	56	57	58	59	60	61	62	63	Mean
Atlantic U. S.				4	5	9	5	3	6	2	2	58.9
Gulf U. S.		1	1	3	1	5	10	5	5	–	1	58.8
Mexico				1	1	1	3	2	2	1		59.3
Colombia-Surinam			3	5	5	8	6	3	2			57.8
Brazil-Argentina	2	1	–	–	2	2						55.7

	Upper-lower limb gillrakers									
	46	37	48	49	50	51	52	53	54	Mean
Atlantic U. S.	1	2	7	4	9	3	5	3	1	49.9
Gulf U. S.			4	4	13	6	2	3	2	50.4
Mexico		1	–	3	3	–	–	2	1	50.4
Colombia-Surinam	2	–	4	7	6	8	4	2	1	50.1
Brazil-Argentina					1	2	1	–	3	52.3

	Scales-scutes in lateral line										
	68	69	70	71	72	73	74	75	76	77	Mean
Atlantic U. S.		1	5	4	11	6	3	2			72.0
Gulf U. S.			3	3	6	4	2	1	1		72.3
Mexico			2	1	2	1	1	1			72.1
Colombia-Surinam				2	6	10	5	3	3	1	73.5
Brazil-Argentina	1	–	–	1	3	2					71.6

both sides, 23 have one more scale or scute on one side, 15 have 2 more, 6 have 3 more, and 2 have 4 more.

Branchiostegal rays. Three ceratohyal and four epihyal rays on both sides of 41 specimens.

Vertebrae. Ten precaudal and fourteen caudal centra in 21 specimens.

Body proportions. Head length about 27.6-32.8 per cent SL, decreasing slightly above 200 mm SL. Snout length about 8.3-11.4 per cent SL. Eye diameter about 7.8-10.0 per cent SL, decreasing to less than 9.2 per cent SL at sizes larger than 200 mm SL. Postorbital head length about 10.0-13.8 per cent SL, decreasing slightly at larger sizes. Upper jaw length about 10.7-12.9 per cent SL. Maximum depth of upper jaw about 2.8-3.8 per cent SL. Body depth (maximum vertical) 24.2-27.5 per cent SL, average of about 25 per cent SL (Fig. 4).

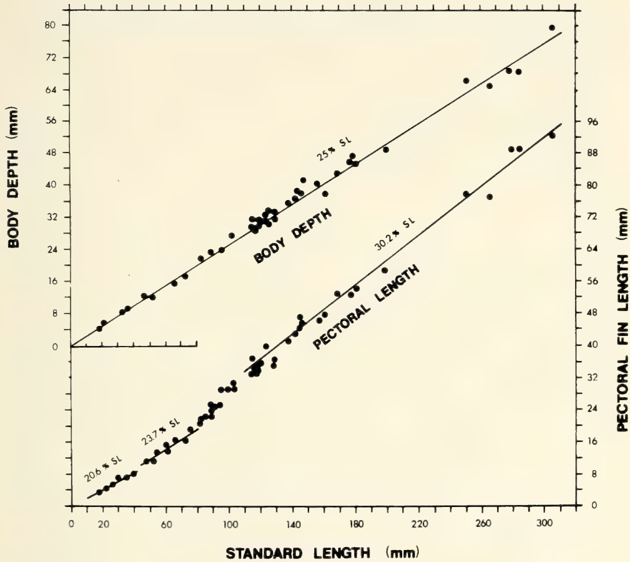


Fig. 4. Relation of body depth (maximum vertical) and pectoral fin length for *Trachurus lathami*. The regression lines and per cent SL values were determined visually.

Geographic variation. Several meristic characters suggest shifts of values by area of capture. Three character index values are used in Table 12 to illustrate this suggestion, although the samples available from different areas are insufficient to define or suggest the possible existence of subpopulations. Tabulations of the three characters disclose that specimens from the United States and Mexico are generally similar.

Counts of the sums of dorsal and anal softrays disclose that the Colombia-Surinam sample averages more than one ray less than the North American sample; the Brazil-Argentina sample averages two rays less than the former. These counts suggest a decreasing cline from north to south.

Counts of the sums of upper limb and lower limb gillrakers show that the U.S.-Mexico and the Colombia-Trinidad samples are similar, but that the Brazil-Argentina sample has two or more additional gillrakers, which suggests a south temperate shift.

Counts of the sums of scales and scutes in the lateral line reveal that the Colombia-Surinam sample has the highest average value, which suggests a parabolic cline with increasing values in higher latitudes.

ACKNOWLEDGMENTS

This research was conducted through the Systematics of Fishes Program of the Tropical Atlantic Biological Laboratory (TABL). It was sponsored in part by the Laboratory Research Program of Dade County Public Schools coordinated by James F. Miley. Phillip C. Heemstra, Tomio Iwamoto, and Grady W. Reinert of the TABL staff assisted in the research and preparation of the report.

We are grateful to the following individuals and institutions for providing information on specimens and making specimens available: Marie L. Bauchot, Muséum National d'Histoire Naturelle (MNHN); Heraldo A. Britski, Departamento de Zoologia São Paulo (DZSP); Harvey R. Bullis, USBCF Exploration and Gear Research Base, Pascagoula; Daniel M. Cohen and Bruce B. Collette, USBCF Systematics Laboratory, Washington; William N. Eschmeyer, California Academy of Sciences; Warren C. Freihofer and George S. Meyers, Stanford University (SU); Robert H. Gibbs, Jr. and Stanley H. Weitzman, U. S. National Museum (USNM); Carter R. Gilbert, University of Florida (UF); P. H. Greenwood and Peter J. P. Whitehead, British Museum of Natural History (BMNH); Leslie W. Knapp, Smithsonian Oceanographic Sorting Center; G. E. Maul, Museu Municipal do Funchan (MMF); Giles W. Mead, Tyson Roberts, and Myvanwy Dick, Museum of Comparative Zoology (MCZ); Jørgen Nielsen, Universitetets Zoologiske Museum (ZMC); M. J. Penrith and Frank H. Talbot, South African Museum (SAM); C. Richard Robins, Rosenstiel School of Marine and Atmospheric Sciences (UMML); Donn C. Rosen and C. Lavett Smith, American Museum of Natural History (AMNH); Margaret M. Smith, J. L. B. Smith Institute of Ichthyology; and Loren P. Woods, Field Museum of Natural History (FMNH).

SPECIMENS EXAMINED

Trachurus mediterraneus (26 specimens, 60.5-156 mm SL): Europe, USNM 3563, 1 (116). Italy, AMNH 1508, 1 (95). Sebastopol, USNM 37248, 1 (127). Lebanon, TABL 104857, 6 (135-156); TABL 104707, 11 (60.5-135). Black Sea, UMML 22344, 1 (74); MCZ 41942, 5 (86.5-149).

Trachurus picturatus (19 specimens, 95-435 mm SL): Azores, MCZ 16921, 1 (95); MCZ 16922, 1 (98). Madeira, TABL 105887, 5 (150-356); MMF 3858, 1 (240); MMF 3859, 1 (233); MMF 21674, 1 (204); MMF 3432, 1 (158); MMF 4616, 1 (154); MMF 3421, 1 (152); MMF 8860, 1 (144); MMF 3861, 1 (139); MMF 3430, 1 (113). France (Nice, MNHN B.869, 1 (415) holotype of *Caranx suareus*. Tristan de Cunha, BMNH 1935.5.2.3, 1 (412) holotype of *Decapterus longimanus*; BMNH 1927.12.6.76, 1 (412).

Trachurus trachurus × *T. picturatus* (3 specimens, 146-200 mm SL): TABL 106537, 1 (146); MMF 5207, 1 (200); MMF 5305, 1 (192).

Trachurus trecae (528 specimens, 29-225 mm SL): Mauritania, MNHN 50-71, 2 (158-178) syntypes of *T. trecae*. Guinea, TABL 103676, 10 (147-194); TABL 103681, 11 (121-148); TABL 103664, 2 (104-163); TABL 103672, 13 (114-124); TABL 102873, 1 (157). Ivory Coast, TABL 102762, 1 (103). Ghana, TABL 105446, 3 (110-122); TABL 105440, 4 (111-151); TABL 105441, 1 (99); TABL 105440, 1 (108); TABL 103629, 3 (101-115). Dahomey, UMML 16398, 14 (89-109); UMML 16586, 1 (119); UMML 16783, 4 (83-97). Nigeria, TABL 102764, 3 (129-134); TABL 102768, 1 (110); UMML 21320, 1 (125); UMML 15792, 17 (90-101); UMML 16033, 2 (91-107). Cameroon, TABL 102776, 3 (140-200). Gabon, TABL 102785, 8 (102-182); TABL 102787, 9 (124-144); TABL 105445, 1 (147); TABL 102781, 6 (120-140); TABL 103686, 7 (114-123); TABL 103684, 2 (117-126); TABL 102786, 4 (117-123); TABL 103691, 1 (120); TABL 103687, 5 (110-119); TABL 105442, 6 (128-152). Congo, TABL 103688, 1 (120); TABL 103689, 1 (111); TABL 105443, 11 (29-44); TABL 103666, 3 (103-107). Angola, TABL 102791, 6 (180-225); TABL 102792, 4 (181-210); TABL 102790, 5 (160-190); TABL 103695, 102 (78-117); TABL 103784, 62 (54-153); TABL 103783, 36 (58-197); TABL 103722, 104 (89-184); TABL 103271, 41 (71-172); TABL 105864, 1 (214); TABL 105867, 4 (155-176).

Trachurus trachurus (32 specimens, 44.5-273 mm SL): Norway, USNM 23047, 2 (44.5-67); USNM 22067, 2 (45-68); MCZ 2968, 2 (65.5-75.5). Denmark, USNM 39766, 1 (80). Spain (Cadiz), MCZ 22468-9, 2 (153-156). Italy, AMNH 7181, 2 (131-133). Lebanon, TABL 104887, 14 (63-95). Madeira, MMF 157, 1 (174); MMF 2733, 1 (160); MMF 3016, 1 (252); MMF 3207, 1 (273); MMF 3409, 1 (256); MMF 3831, 1 (121); MMF 4052, 1 (149).

Trachurus capensis (6 specimens, 175-342 mm SL): Nigeria, TABL 103663, 3 (209-242). South Africa, SAM 11915, 1 (175); SAM 11920, 1 (272); SAM 11947, 1 (342).

Trachurus margaretae (6 specimens, 68.5-175 mm SL): South Africa, USNM 153510, 3 (68.5-99); USNM 93661, 1 (123) holotype of *T. margaretae*; SAM 16734, 1 (174); TABL 107267, 1 (175).

Trachurus indicus (9 specimens, 89-176 mm SL): Oman, TABL 105384, 3 (168-176); TABL 105998, 1 (174); TABL 106517, 2 (89-103). Persian Gulf, ZMC CN. 3-5, 3 (118-126).

Trachurus mccullochi (19 specimens, 78-252 mm SL): Australia, New South Wales, USNM 48810, 2 (111-120); USNM 59919, 10 (99-160); USNM 83046, 1 (124); USNM 148618, 1 (100); USNM 177110, 2 (78-131). New Zealand, USNM 83061, 1 (252); USNM 177075, 2 (166-227).

Trachurus declivis (4 specimens, 163-270 mm SL): Australia, BMNH 1917.7.14.30, 1 (163) holotype of *Caranx declivis;* USNM 177009, 1 (164). New Zealand, USNM 177075, 2 (205-270).

Trachurus japonicus (13 specimens, 70-295 mm SL): Japan, FMNH 59421, 1 (285) holotype of *T. argenteus*; AMNH 26826, 6 (118-128). China, TABL 107255, 1 (227); TABL 107256, 1 (295); USNM 130405, 1 (215); USNM 130608, 1 (254); MCZ 26324, 2 (70-76.5).

Trachurus symmetricus (26 specimens, 104-525 mm SL): Oregon, SU 14375, 1 (380) holotype of *Decapterus polyaspis*; USNM 143676, 1 (392) paratype of *D. polyaspis*. California, TABL 106328, 7 (303-490). Mexico, Baja California, TABL 105868, 1 (148); TABL 105876, 6 (120-179); TABL 105875, 3 (104-107); TABL 105871, 1 (141); TABL 105876, 6 (132-225); TABL 106329, 1 (525).

Trachurus murphyi (17 specimens, 94-552 mm SL): Peru, AMNH 7859, 1 (296) putative neotype of *T. murphyi*; AMNH 7260, 1 (295); TABL 105862, 1 (176); TABL 103720, 3 (361-418); TABL 103718, 2 (378-392); TABL 104487, 1 (169); TABL 104481, 1 (200). Chile, TABL 103719, 4 (126-270); TABL 104690, 1 (94); TABL 105587, 2 (548-552).

Trachurus lathami (142 specimens, 19-305 mm SL); Massachusetts, MCZ 37141, 1 specimen (91 mm SL). New York, AMNH 7351, 1 (96) holotype of *T. lathami*. North Carolina, TABL 105058, 1 (147); TABL 103653, 1 (115). Georgia, USNM 198978, 2 (132-134), TABL 105053, 2 (96.5-102). Florida Atlantic, TABL 103656, 3 (54.0-71.5); TABL 105056, 4 (120-145); TABL 105066, 1 (35); TABL 105065, 3 (19-33); TABL 105436, 24 (122-146); TABL 103597, 2 (47.8-50.5). Florida Gulf, USNM 198972, 1 (106); USNM 199025, 1 (60); USNM 198985, 2 (146-152); USNM 198981, 7 (62.5-71.5); TABL 106581, 3 (116-123); USNM 198980, 5 (55-73); UF uncat., 1 (150). Alabama, AMNH 15212, 1 (73) holotype of *T. picturatus binghami.* (87 specimens, 57.5-305 mm SL): Mississippi, TABL 105083, 2 (115-125); USNM 198984, 2 (140-141); USNM 198975, 1 (69.5). Louisiana, USNM 199033, 3 (140-143); USNM 198988, 3 (146-158); TABL 105073, 1 (156); TABL 105046, 1 (144); USNM 198989, 1 (182). Texas, USNM 198982, 2 (102-104); TABL 105047, 2 (121-161). Campeche, Mexico, TABL 105048, 1 (138); USNM 198979, 3 (112-140); USNM 199031, 2 (138-139); USNM 199030, 1 (117); USNM 199030, 1 (139). Tabasco, Mexico, USNM 198971, 2 (57.5-81). Colombia, TABL 103205, 4 (117-129); TABL 105077, 1 (153); TABL 101540, 8 (125-183); TABL 101475, 1 (251); TABL 105074, 11 (75.5-103). Venezuela, TABL 105863, 1 (196); TABL 101474, 10 (115-127); TABL 107268, 1 (116); TABL 107269, 2 (106-110). Grenada, TABL 105075, 2 (124). Trinidad, TABL 105072, 4 (169-200); TABL 101836, 2

(146-266); TABL 104854, 1 (305); TABL 105597, 1 (278). Surinam, TABL 105596, 1 (285); UMML 4007, 1 (198). French Guiana, UMML 11586, 1 (181). Brazil, São Paulo, DZSP 5249, 5 (135-146). Argentina, SU 52384, 2 (83-150).

LITERATURE CITED

ALEEV, Y. G. 1956. The systematic position of the Black Sea mackerel *Trachurus*. In Russian. Voprosy Ikhtiologii, vol. 7, pp. 174-184.

AYRES, W. O. 1855. Description of new species of California fishes. Proc. California Acad. Sci., vol. 1, p. 62.

BARNARD, K. H. 1927. A monography of the marine fishes of South Africa. Part II. Ann. South African Mus., vol. 21, no. 2, pp. 419-1065.

BERRY, F. H. 1968. A new species of carangid fish (*Decapterus tabl*) from the western Atlantic. Contr. Mar. Sci., vol. 13, pp. 145-167.

———. 1969. *Elagatis bipinnulata* (Pisces: Carangidae): Morphology of the fins and other characters. Copeia, no. 3, pp. 454-463.

BLANC, M., AND M. L. BAUCHOT. 1961. Sur quatre generes de Carangidae (Téléostéens Perciformes) de la côte occidentale d'Afrique: *Decapterus, Caranx, Trachurus, Suareus*. Affinités et rapports phylogéniques. Bull. Mus. Nat. Hist. Nat., 2 Ser., vol. 32, no. 6, pp. 484-497.

BOWDICH, T. E. 1825. Fishes of Madeira (*In*) Excursions in Madeira and Porto Santo . . . G. B. Whittaker, London, pp. 121-125.

CADENAT, J. 1949. Description de quatre Téléostéens nouveaux de la côte occidentale d'Afrique. Bull. Mus. Nat. Hist. Nat., 2e Ser., vol. 21, no. 6, pp. 663-671.

CAPELLO, F. B. 1868. Description de trois nouveaux poissons des mers du Portugal. Journ. Sci. Math. Phys. Nat. Lisboa, vol. 1, pp. 318-322.

CASTELNAU, F. L. 1861. Mémoire sur les poissons de l'Afrique australe. Paris, vii + 78 p.

COCCO, A. 1829. Sopra un nuovo specie di *Trachurus*. Giorn. Inominato, Messina, 1 p.

CUVIER, G., AND A. VALENCIENNES. 1833. Histoire naturelle des poissons. F. G. Levrault, Paris, vol. 9, pp. 1-512.

FOWLER, H. W. 1938. Descriptions of new fishes obtained by the United States Bureau of Fisheries steamer "Albatross," chiefly in the Phillippine Seas and adjacent waters. Proc. U.S. Nat. Mus. (1938), vol. 85, no. 3032, pp. 31-135.

FURNESTIN, J., J. DARDIGNAC, C. MAURIN, A. VINCENT, R. COUPÉ, AND H. BOUTIÉRE. 1958. Données nouvelles des poissons du Maroc Atlantique. Rev. et Trav. Inst. Pêches Mar., vol. 22, no. 4, pp. 380-493.

GIGLIOLI, E. H. 1880. Pisces. *In* Elenco dei mammiferi . . . e catalogo degli anfibi e dei pesci italiani. Firenze, pp. 18-55.

GRONOVIUS, L. T. 1854. Catalogue of fish collected and described by . . . now in the British Museum. Ed. J. E. Gray. London, 196 p.

JENYNS, L. 1841. Fish. *In* Charles Darwin editor. The zoology of the voyage

of H. M. S. Beagle. Smith, Elder, and Co., London, pt. IV, XVI + 172 p.

JORDAN, D. S. 1917. The genera of fishes. Stanford Univ., Univ. Ser. no. 1, pp. 1-161.

JORDAN, D. S. AND B. W. EVERMANN. 1896. The fishes of North and Middle America. Bull. U.S. Nat. Mus., no. 47, pt. 1, 1240 pp.

LACÉPEDE, B. G. E. 1802. Histoire naturelle des poissons. Plassan, Paris, vol. 3, pp. 1-803.

LINNAEUS, C. 1758. Systema Naturae. L. Salvii, Holminae, ed. 10, vol. 1, pp. 1-824.

LOWE, R. T. 1841. Synopsis of the fishes of Madeira. Trans. Zool. Soc. London, vol. 2, pp. 173-200.

MCCULLOCH, A. R. 1915. Report on some fishes obtained by the F.I.S. "Endeavour." Part III. Commonwealth of Australia, Dept. Trades and Customs, Fisheries.

MALM, A. W. 1877. Göteborgs och Bohusläns fauna. Ryggradsdjuren. Göteborg, 674 p.

NANI, A. 1950. Una nueva subespecie de "Surel," *Trachurus picturatus australis* (Pisc. fam. Carangidae). Pri. Cong. Nac. Pesq. Mar. Ind. Deriv., vol. 2, pp. 167-194.

NECRASSOV, V. V. 1966. A new subspecies of *Trachurus* (*Trachurus mediterraneus indicus* Necrassov subsp. n.) in the Indian Ocean. In Russian. Zool. Zh., vol. 45, pp. 141-144.

NICHOLS, J. T. 1920. A key to the species of *Trachurus*. Bull. Amer. Mus. Nat. Hist., vol. 42, no. 13, pp. 477-481.

———. 1934. On *Trachurus capensis* Castelnau. Copeia, 1935, no. 2, p. 104.

———. 1940. Notes on carangin fishes. V.—Young *Trachurus* in the Gulf of Mexico. Amer. Mus. Novit., no. 1067, 4 p.

NILSSON, S. 1832. Prodromus ichthyologiae scandinavicae. Bertingianis, Lundae, 124 p.

NORMAN, J. R. 1935. The carangid fishes of the genus *Decapterus* Bleeker. Ann. Mag. Nat. Hist., ser. 10, no. 16, pp. 252-264.

PALLAS, P. S. 1811-1842. Zoographia Rosso-Asiatica. Petropoli, 3 vols.

POLL, M. 1954. Poissons. IV. Téléostéens acanthroptérygiens (Première partie). Expéd. Océanogr. Belge Côt. Afr. Atl. Sud (1948-1949), Rés. Sci., vol. 4, no. 3A, pp. 1-390.

RAFINESQUE, C. S. 1810. Caratteri di alcuni nuovi generi e nuove specie di animali e piante della sicila. Sanfilippo, Palermo, 105 p.

———. 1815. Indice d'ittiologia siciliana ossia catalogo metodico dei nomi latini, italiani, e sicilani dei pesci. Presso Giovanni del Nobolo, Messina, 70 p.

RICHARDSON, J. 1842. Report on the present state of the ichthyology of New Zealand. Rept. Brit. Assoc. Adv. Sci., 12th meet., pp. 12-30.

SLASTENENKO, E. P. 1965. The species composition of genus *Trachurus* in the Black Sea. Rapp. Réun. Comm. Int. Explor. Scient. Mer. Méditerr., vol. 18, pp. 269-272.

SMITH, J. L. B. 1961. The sea fishes of South Africa. Cent. News Agency, Ltd., Cape Town, 4th Ed., XVI + 580 p.

STEINDACHNER, F. 1868. Ichthyologischer Bericht über eine nach Spanien und Portugal unternommene Reise. V. Sitzber. Akad. Wiss. Wien, 1. Abth, pp. 351-424.

TEMMINCK, C. J., AND H. SCHLEGEL. 1842-50. Pisces. *In* F. Siebold, editor, Fauna Japonica. A. Arnz et Socios, Lugduni Batavorum, 323 p.

TORTONESE, E. 1952. Monografia dei carangini viventi nel Mediterraneo. Ann. Mus. Civ. Storia Nat. Genova, vol. 45, pp. 259-324.

WAKIYA, Y. 1924. The carangoid fishes of Japan. Ann. Carnegie Mus., vol. 15, nos. 2-3, pp. 139-293.

WALFORD, L. A., AND G. S. MYERS. 1944. A new species of carangid fish from the northeastern Pacific. Copeia, no. 1, pp. 44-47.

WHITEHEAD, P. J. P., M. BOESEMAN, AND A. C. WHEELER. 1966. The types of Bleeker's Indo-Pacific elopoid and clupepoid fishes. Zool. Verh., vol. 84, pp. 1-159.

ADDENDUM

A publication reviewed after our submission of this manuscript recommended a change in synonymy for one of the two Australian species of *Trachurus*. In "A check list of the fishes recorded from the New Zealand region," Australian Zoologist, vol. 15, pt. 1, pp. 1-102, G. P. Whitley listed as synonyms four species described in 1843 by John Richardson, namely: *Scomber clupeoides, Scomber dimidatus, Trachurus novaezelandias,* and *Caranx sinus-obscuri.* We presume that these four might all be junior synonyms of *Trachurus declivis* (Jenys, 1841).

South Carolina Marine Research Laboratory, Charleston, South Carolina 29412; Oberlin College New Media Workshop, Oberlin, Ohio 44074. Contribution no. 205, *National Marine Fisheries Service, Southeast Fisheries Center, Miami Laboratory, Miami, Florida 33149.*

Defensive Behavior in *Rana areolata* and *Hyla avivoca*

Ronald Altig

Agonistic behavior patterns have been reported recently for a number of anurans in several families (e.g., Duellman, 1966; Brattstrom and Yarnell, 1968; Rivero and Esteves, 1969; Villa, 1969). The functions of these patterns have usually been interpreted as being territorial during breeding activities or as protection from predators. *Rana areolata* might be expected to have aggressive behavior patterns for protection in the burrow against predators and accidental intruders. Male *Hyla avivoca* call from elevated perches that they occupy repeatedly each night, and agonistic behavior was observed between such males.

Materials and Methods

Rana areolata from near breeding choruses at State College, Oktibbeha County, Mississippi, were tested. A 65 diameter glass tube projecting at a 20° angle through the floor of a large wooden box served as an artificial burrow. Except for an observation slit that could be covered by an opaque sheath, the tube was painted black. Soil was placed on the floor of the box. Resident frogs (three different individuals) readily ate small crayfish and appeared well adjusted. After a week acclimation period, a shrew (*Blarina brevicauda*), mouse (*Peromyscus leucopus*), snakes (*Natrix rhombifera, Agkistrodon piscivorous*), and other *R. areolata* were guided down the burrow with at least a day between tests. Each intruder was used several times. Other specimens were grouped in 20-gal aquaria.

Male-male interactions between calling *Hyla avivoca* were observed near State College, Mississippi.

Results

As soon as the shrew approached the frog in the burrow, the frog inflated, tilted the body forward so the head was nearly vertical to the substrate, and lunged at the shrew. The frog moved forward rather than move to the end of the burrow, but did not attempt to bite. Multiple lunges followed, depending on the prox-

imity of the intruder, or the frog stood quietly in the tilted posture. Loud screams typically accompanied the lunges and the shrew immediately exited from the burrow. A dead shrew elicited a similar response. Two of the frogs reacted more violently than the other.

When confronted by the mouse or either species of snake, the frog moved to the end of the burrow, inflated, and sat quietly with its head tilted down. Contact by any of the animals did not elicit the overt behavior above. When other frogs were introduced, the resident showed little response, but if the frogs were maintained in a group, each individual seen chose a favored resting place that did not contact another frog if space allowed. Several times during a feeding frenzy, a frog went beneath a piece of cardboard that was the hiding place of a large male; usually the intruder would exit rapidly, often in reverse, and the resident often followed to the edge of the cardboard. Food was not involved.

If a specimen fresh from the field or one that had been allowed to live in the artificial burrow was placed in the open, it routinely assumed the posture shown in Fig. 1 when harrassed. Grouped specimens seemed to lose this response quickly. Particularly touchy individuals would behave thusly if one waved a hand over them three feet away, while others needed to be touched. Contact on the side caused the frog to tilt toward the contact point, and contact on the head caused the frog to tilt the head down, stretch the rear legs posteriorly, and lunge when touched. No sound or biting was noticed.

Fig. 1. Defensive behavior in *Rana areolata*. Position assumed at approach by shrew (left) and mouse or snakes (right).

On two occasions, the calling perch of the male *Hyla avivoca* was invaded by another male; fighting ensued and in both cases the resident won and the intruder retreated. In the first incidence, the resident became aware of the other from about 18 inches away, switched from a normal call to a short trilling chirp, oriented toward the other frog, and approached him. Without contact, the resident seemingly recognized the intruder as non-female and initiated a grappling fight that start with an amplectic-type grasp around the head from the frong. He chirped continually and jerked the frog with his front legs about once every 5-10 seconds. The intruder tried to escape, the pair fell about 10 inches to a lower branch, and the intruder finally escaped. The resident returned to near his original post and began calling within 4 min. The total encounter lasted about 8 min.

The second fight was similar, although the resident often seemed to be losing the fight, and the total fight lasted about 15 min. Grasping with the front legs, jerking the intruder with the front legs, kicking with the back legs, and chirping were prominent components of the fight. The intruder in each case seemed to be primarily concerned with getting away.

DISCUSSION

Rana areolata resembles only *R. pipiens* behaviorly. Most individuals are caught crossing roads to breeding choruses, and when approached they seem complacent and often crouch with the forelegs over the eyes. If handled gently, they continue this posture even after being picked up, but if they became alarmed, they escaped in frantic leaps or kick wildly if restrained. Perhaps in the grassy areas where they spend most of their time they rely on camouflage, and the crouching position and dorsal pattern facilitates this; observations of individuals in pens bear this out.

Blarina enter the burrows of *R. areolata* frequently and probably would not hesitate to attack at least a small frog. The response of the frog indicates this intruder is not a welcome symbiont, and the elicitation of the behavior by dead shrew may indicate that olfaction and not movement is important in causing a response. A mouse of similar size caused no response, but *Peromyscus* are not noted carnivores and lack salivary venom. It seems the frog would respond to the snakes, but perhaps a motionless frog is less attrac-

tive to the snake (Diefenbach and Emslie, 1972). In such an inflated position at the end of the burrow, the frog presents large areas of the glandular dorsolateral folds to the predator as well as being turgid and difficult to grasp in the confines of the burrow.

The response of individuals in the open to motion overhead may indicate birds (such as marsh hawks, *Circus*) are common predators. If crouching and camouflage fails, the frog stands high on its legs to increase its apparent size and attempts to place large glandular areas in the line of attack of the predator.

In summary, this solitary species has defensive behavior patterns directed at predators and conspecifics. Perhaps the behavior would have been more intense had the test animals not been breeding, a time when at least the later behavior would have to be nullified. The defensive stance is similar to that of *Leptodactylus pentadactylus* (Villa, 1969), also a burrow-inhabiting species. No defensive postures could be elicted from *Scaphiopus holbrooki*. *Rhinophrynus dorsalis* that had been allowd to burrow would react when harrassed. They spread the hind legs straight behind, stood high on the front legs, and bent the head vertically between the legs. This posture plus the inflated body nearly hid the head. Neither of these species was tested with predators.

The behavior of the male *H. avivoca* likely serves as a spacing mechanism around the pond; at this small pond there is a large population of *H. avivoca*, and they are concentrated primarily in small patches of button bush. The chirping call is typical of this species when another frog of similar size approaches and may serve to orient the female during the last few feet. *H. cinerea* and *Gastrophryne carolinensis* have a similar call.

LITERATURE CITED

BRATTSTORM, B. H., AND R. M. YARNELL. 1968. Aggressive behavior in two species of leptodactylid frogs. Herptelogica, 24, no. 3, pp. 222-228.

DIEFENBACH, C. O., AND S. G. EMSLIE. 1971. Cues influencing the direction of prey ingestion of the Japanese snake, *Elaphe climacophora* (Colubridae, Serpentes). Herpetologica, 27, no. 4, pp. 461-466.

DUELLMAN, W. E. 1966. Aggressive behavior in dendrobatid frogs. Herpetologica, 22, no. 3, pp. 217-221.

RIVERO, J. A., AND A. E. ESTEEVES. 1969. Observations on the agonistic and breeding behavior of *Leptodactylus pestadactylus* and other amphibian species in Venezuela. Breviora 585, no. 321, pp. 1-4.

VILLA, J. 1969. Compartamiento defensive de la "Rana ternero", *Leptodactylus pentadactylus*. Rev. Biol. Trop., 15, no. 2, pp. 323-329.

Department of Zoology, Mississippi State University, State College, Mississippi 39762.

Quart. Jour. Florida Acad. Sci. 35(4) 1972 (1974)

Commercial Fishery on Lake Okeechobee, Florida

LOTHIAN A. AGER

LAKE Okeechobee is a fresh water lake of approximately 450,000 surface acres with an average depth of 8.5 feet at elevation 13.5 feet above mean sea level. Maximum depth at normal elevation is about 17 feet. Nearly one-seventh of the lake is littoral zone occupied with a variety of aquatic plants, but predominately *Scirpus, Typha, Eleocharis, Fuirena, Eichhoria crassipes, Pistia stratiotes, Potamogeton illinoensis,* and *Vallisneria americana.* Bottom substrates vary from marl, sand, shell, muck, and rock. The lake basin is approximately circular. Water control structures are located on all major inlets and outlets to prevent extreme fluctuation of the water level.

Past data indicate that Lake Okeechobee was of great economic importance for commercial fishing and sport fishing. Until 1946 the commercial harvest consisted primarily of catfishes (*Ictalurus* spp.), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), and shellcracker (*L. microlophus*) and was a substantial influence on the local economy. When Lake Okeechobee came under the jurisdiction of the Florida Game and Fresh Water Fish Commission in 1946 restrictions on both gear and species were induced by organized sportsmen in the belief that reduced or eliminated commercial harvest of the panfishes would increase benefits to sport fishermen.

Much unsubstantiated argument has taken place, both pro and con, on the commercial aspects and their effects on sport fishing. I intend to present factual information concerning the present status of the commercial fishery and to explore ideas on the potential exploitation of the available resources.

GEAR AND SPECIES HARVESTED

Under present regulations of the Florida Game and Fresh Water Fish Commission, legal commercial gear is limited to wire traps, trotlines, and pound nets and haul seines under special permit. Wire traps are limited to a maximum length of seven feet, a maximum diameter of thirty-two inches, a minimum mesh size of one inch and a maximum mesh of one and one-half inches, and a fun-

nel in one end only. Traps may not be fished in less than four feet of water. Each licensee is permitted eighty traps. Trotlines are limited to 1500 hooks during the daylight hours and an unlimited number at night. Maximum length and depth of pound nets is limited to ten feet by twelve feet with a minimum mesh size of two inches stretched. All devices must be adequately marked to identify the licensee.

Wire traps are normally baited with pressed cottonseed and soybean cake broken into five or six inch squares and sandwiched together with large rubber bands. Between one and two pounds of bait is placed in the trap at each fishing, which occurs about every third day. Each trap fisherman normally has about 150 traps and fishes fifty each day, weather permitting.

Trotlines are baited with a variety of material, including shrimp, maggots, grubs, dead minnows, soap, and occasionally hooks are painted and fished without bait. Most trotlines are fished during the night, being set before dark and removed soon after daylight. However, some lines are left in the water at selected locations and fished daily.

Commercial gear is to be used for the taking of non-game fish and turtles. In Lake Okeechobee the commercial harvest consists of channel catfish (*Ictalurus punctatus*), white catfish (*Ictalurus catus*), brown bullheads (*Ictalurus nebulosus*), yellow bullheads (*Ictalurus natalus*), assorted hard-shelled turtles, and soft-shelled turtles (*Trionyx ferox*). The catch of turtles is usually incidental to fishing operations.

COMMERCIAL LICENSES

During the 1967-68 season, approximately 275 commercial fishermen operated under nearly 500 commercial licenses (data obtained from boat registration and license sales records of the Game and Fresh Water Fish Commission), compared to 138 fishermen during the 1952-53 season (Dequine, 1953). The larger number of licenses than fishermen results from the practice of some fishermen purchasing licenses in his relatives' names as well as his own, in order to be entitled to operate additional commercial fishing gear. A retail fish dealer's license is required in order to operate commercial fishing gear and entitles the holder to sell fish and supplies in any manner directly to the consumer or wholesaler. The license fee

is $5.00 and must be accompanied by the possession of a valid sport fishing license at a cost of $3.25.

Commercial fishing boats must be registered as such at a cost rate according to the size of the boat.

Discussion

Presently five wholesale fish dealers buy fish taken from Lake Okeechobee. One of these dealers is from another part of the state so that records on the poundages of fish that he purchased are not readily available. The poundages of fish from Lake Okeechobee included here (Table 1) were obtained from fish dealers in the area. During the period from 1 January 1968 to 1 January 1971, a total of 3,005,811 pounds of dressed channel and white catfish from Lake Okeechobee were handled by these wholesale fish dealers. This represents an annual average harvest of 1,001,937 pounds dressed weight. These figures represent an increase over a previous average figure for a ten-year period from 1936 through 1945 (Table 2) of 1,192,647 pounds of catfish rough weight (Dequine, 1951).

The average annual catch of bullheads during the recent period was 45,600 pounds dressed weight. The average annual catch of turtles was 10,248 pounds dressed.

The average annual catch of channel and white catfish represents a value to the commercial fishermen of $450,871.65 at the average price paid of $.45 per pound dressed. The bullheads and turtles represent a value of $19,567.80 for an average annual total value to the some 275 commercial fishermen of $470,439.45. The total value of the channel and white catfish to the wholesale fish dealers at the average wholesale price is $651,259.05 as compared to $241,523.00 for all food fish during the 1952-53 study (Dequine, 1953).

The costs of commercial gear to the fishermen is difficult to determine. Materials for wire traps are about $3.00 each plus labor. Trotlines cost 3-6 cents per hook depending upon the quality and quantity of the material used. No pound nets or haul seines are in operation at the present. Bait for traps cost 20-30 cents per trap. Bait for trotlines varies in cost depending upon the bait and the individual fishermen. Gasoline for operation of commercial boats is approximately $2.00 per trip. The cost of boats and motors has not been estimated.

TABLE 1. Monthly harvest (pounds dressed weight) of catfish and turtles

	Month	Channel and White catfish	Bullheads	Turtles
1968	January	66,160	11,165	403
	February	39,953	8,120	491
	March	33,969	5,669	1,686
	April	54,044	2,495	3,319
	May	60,536	1,477	1,557
	June	59,582	1,230	527
	July	103,756	1,267	761
	August	65,537	1,808	1,072
	September	59,311	2,138	1,115
	October	51,441	2,952	792
	November	46,444	3,065	405
	December	77,845	5,045	227
	Total	718,578	46,431	12,355
1969	January	87,184	9,670	230
	February	54,506	3,586	502
	March	54,462	2,288	488
	April	73,317	2,416	719
	May	93,699	2,186	1,389
	June	105,555	1,652	995
	July	85,114	6,068	996
	August	81,742	4,833	960
	September	50,299	3,658	1,523
	October	71,908	2,209	640
	November	70,549	4,047	520
	December	133,006	3,754	133
	Total	961,341	46,367	9,095
1970	January	131,496	2,380	55
	February	115,900	3,198	115
	March	148,258	3,190	679
	April	163,431	1,384	1,000
	May	108,170	2,040	673
	June	126,261	2,084	1,227
	July	93,406	2,700	976
	August	81,201	6,452	1,517
	September	67,798	5,675	1,144
	October	83,569	4,674	1,023
	November	86,326	6,106	381
	December	120,076	4,300	506
	Total	1,325,892	44,183	9,296
Grand total		3,005,811	136,981	30,746
Monthly average		83,495	3,805	854
Annual average		1,001,937	45,660	10,248
Lbs./acre/year		2.2	0.1	0.02

TABLE 2

Total catch (pounds rough weight) of bream, catfish, and crappie reported from Lake Okeechobee 1936 through 1945 (Dequine, 1951).

Year	Bream	Catfish	Crappie
1936	258,900	1,714,100	302,100
1937	541,800	932,400	343,700
1938	540,100	1,074,900	434,700
1939	540,800	1,180,600	721,000
1940	396,800	1,529,900	605,800
1941	121,628	1,551,924	784,351
1942	103,492	446,385	91,074
1943	682,717	919,469	359,613
1944	607,281	1,143,626	292,123
1945	494,991	1,433,168	287,913
Total	4,288,509	11,926,472	4,222,374
Average	428,851	1,192,647	422,237
Average lbs. per acre	0.95	2.65	0.94

Figures from 1936 through 1940 were obtained from "Fishery Industries of the U.S." published by the U.S. Department of Commerce and Interior; those from 1941 through 1945 were obtained from annual bulletins entitled "Recapitulation of Fish Census" issued by the Florida Board of Conservation.

PROJECTION

The harvest of channel and white catfish during the three year period from 1 January 1968 to 1 January 1971 represents a catch of about 2.2 pounds dressed per surface acre of water per year. Over a year's time this figure is below the potential natural production as indicated by an annual removal of 61.71 pounds per acre rough weight of catfishes from Lake George (Table 3) over a ten year period (Dequine, 1951). One may assume that Lake Okeechobee has a greater potential primary productivity per unit area now than formerly because of the increased harvest so that potential production of fish is greater. This results from more intensive agricultural practices, the increased population of the area together with canal construction and levee confinement of the lake and tributaries affecting the nutrient content of the water. Because of the tremendous sport fishery on Lake Okeechobee, however, commercial restrictions are so stringent as to prevent the harvest of any game fish and thus limit the harvest of catfish. The harvest of catfish from Lake Okeechobee does represent a significant portion of the econ-

TABLE 3

Total catch (pounds rough weight) of bream, catfish, and crappie reported from Lake George 1936 through 1945 (Dequine, 1951).

Year	Bream	Catfish	Crappie
1936	382,900	2,320,000	146,100
1937	249,300	3,087,700	146,600
1938	506,500	2,569,200	114,100
1939	81,500	—	401,100
1940	—	—	136,100
1941	425,790	2,561,562	129,271
1942	626,983	2,797,681	166,841
1943	583,552	3,356,977	367,747
1944	780,684	2,868,075	261,119
1945	885,298	3,672,136	389,340
Total	4,522,507	23,233,431	2,258,318
Average	502,501	2,904,178	225,831
Average lbs. per acre	10.67	61.71	4.79

Figures from 1936 through 1940 were obtained from "Fishery Industries of the U.S." published by the U.S. Department of Commerce and Interior; those from 1941 through 1945 were obtained from annual bulletins entitled "Recapitulation of Fish Census" issued by the Florida State Board of Conservation.

Figures for catfish for 1939 and 1940 were available only for the eastern "district" of Florida and could not be broken down into the area concerned.

Figures for bream for 1940 in question.

omy of the five surrounding counties and to those individuals who rely in whole or in part on commercial fishing for their livelihood.

During the two-year study by the Florida Game and Fresh Water Fish Commission from 1948 to 1950 (Dequine, 1951), there was no evidence that the harvest of catfishes had either beneficial or detrimental effects on the composition of game, commercial, or rough fishes. The past data demonstrated that the harvest of fish by the methods employed did not reduce numbers of the species from year to year because of the relatively small percentage of younger fish taken in the operations. This assured the following year's crop. During the study from 1952 to 1953 in which bream and crappie were included as commercial species, no indications of decreased yield of desired species of fish to either sport or commercial fishermen were evident other than those of a seasonal nature (Dequine, 1953). The natural potential production of bream

TABLE 4

Estimated potential annual harvest of bream, catfish, and crappie from Lake Okeechobee based on sustained annual harvest from Lake George with respective monetary values.

	Bream	Catfish	Crappie
Surface acres	450,000	450,000	450,000
Estimated Potential Annuar Harvest/Acre	10 lbs.	61 lbs.	5 lbs.
Total Harvest	4,500,000	27,450,000	2,250,000
Average Market Price/Pound	$.25	$.45	$.25
Estimated Potential Annual Value	$1,125,000	$12,352,500	$562,500
Grand Total	$14,040,000		

Prices quoted are those paid to the commercial fishermen by the wholesale fish dealers or illegal fish buyers.

and crappie (Table 3) is evidenced by the commercial removal of 10.67 and 4.79 pounds per acre, respectively, over a ten-year period from Lake George (Dequine, 1951) without any measurable detriment to the sport fishery resource.

In order to more fully utilize the fishery resources available in Lake Okeechobee, a more intensive commercial harvest program must be applied. In addition, harvest of all species of fish must be accomplished which necessitates creation of a demand for presently undesirable rough fish. An expansion of the commercial fishery would provide a direct economic benefit to the fishermen in excess of $14,000,000.00 per year based on potential harvest information and present market prices (Table 4). To accomplish this objective, commercial gear other than that allowed must be permitted. To provide for supervision of the expanded industry, legislative action must occur to establish a tax based on poundages harvested in order that the industry is regulated by monies of its own creation.

SUMMARY

Commercial fishing gear permitted on Lake Okeechobee consists of wire traps, trotlines, and pound nets and haul seines under special permit. Channel catfish, white catfish, brown bullheads, yellow bullheads, and turtles comprise the commercial harvest. Approximately 275 commercial fishermen took 3,005,811 pounds of

channel and white catfish dressed weight during the period 1 January 1968 through 1 January 1971; 136,981 pounds dressed of bullheads, and 30,746 pounds dressed of turtles representing a direct income to the fishermen of $1,411,318.35. The harvest represents a catch of 2.2 pounds of channel and white catfish per surface acre per year which is about 5 per cent of the potential harvest. Restrictions on fishing gear to prevent harvest of bream and crappie as well as bass restrict the harvest of the present commercial species. Previous studies by the Florida Game and Fresh Water Fish Commission determined that the commercial harvest of crappie, bream, and catfishes would have neither detrimental nor beneficial effects on sport or commercial fishing. To utilize more fully the fishery resource of Lake Okeechobee, the commercial harvest of virtually all species of fish must occur with commercial gear other than that presently allowed. With a commercial harvest approaching known potential production, the result would be an increase to the local economy in excess of $14,000,000.00 annually and through legislative action could provide monies for supervision and regulation of the industry.

LITERATURE CITED

DEQUINE, JOHN F. 1961. Investigations of the Saint Johns River and Lake Okeechobee, 1948-1950, with recommendations for management. Florida Game and Fresh Water Fish Commission, 46 pp. (unpublished report).

———. 1953. Preliminary progress report on Florida's controlled seining program, 1 April 1952 through 28 February 1953. Florida Game and Fresh Water Fish Commission, 31 pp. (unpublished report).

Florida Game and Fresh Water Fish Commission, 1140 S. Osceola Stree, Okeechobee, Florida 33472.

Nuclear DNA and Developmental Rate in Frogs

K. Bachmann

Goin et al. (1968) described a relation between the time spent as a tadpole in 21 species of frogs and their diploid nuclear DNA amount. The interval from hatching to metamorphosis is from two to four weeks in frogs with low nuclear amounts of DNA (*Scaphiopus, Hyla septentrionalis*) whereas species of *Rana* with high nuclear DNA amounts may overwinter as tadpoles. The tadpole stage is subject to a variety of factors that influence its duration, such as temperature and differences in the stage at hatching.

Early embryonic development can be timed much more accurately and the strong dependence of embryonic developmental rate on temperature allows adjustments for temperature effects (Bachmann, 1969). When the time elapsed at 20°C between the two-cell stage and early tail bud stage (stage 16 of Pollister and Moore, 1937) is compared with nuclear DNA amounts in eleven species of frogs for which such data exist, there results a straight-line relation (Bachmann, in preparation).

Such striking correlation between nuclear DNA and developmental rate could be of considerable significance if it holds true for all frogs. Precise data on developmental rates under controlled conditions are rare and all species for which such data have previously been available are found in relatively mesic regions. Recently, the temperature dependence of developmental rate has been determined for several anuran species of the arid southwestern United States (Zweifel, 1968). Since no species from such an environment was in the earlier sample, they presented particularly suitable material for another test of the relation between nuclear DNA and developmental rate.

Experimental Methods

Specimens of *Bufo cognatus, B. debilis, B. punctatus, Rana pipiens, Scaphiopus bombifrons, S. couchi,* and *S. hammondi* were obtained from the vicinity of the Southwestern Research Station at Portal, Arizona. Nuclei were prepared from kidney and liver tissue fixed in a 3:1 mixture of ethanol and glacial acetic acid for two

hours and from liver tissue fixed in ice cold 10 per cent formalin by homogenizing in a 0.1 per cent solution of Tween 80. Washed free from the detergent the nuclei were spread on slides, air dried, and stored dry until staining. Feulgen staining was preceded by hydrolysis in 5 N HCl at room temperature for prolonged periods of time (30, 50, 60, 90 or 100 minutes) or in 1 N HCl at 60°C for 15 minutes. Total dye bound by individual nuclei was measured at 550 nm on a Barr and Stroud Integrating Microdensitometer. In order to convert the absorption measurements to picograms (pg) of DNA, specimens of *Bufo bufo, B. marinus, B. terrestris,* or *Rana speno-cephala* were included in the experiments. Approximate diploid DNA amounts for these species are 14.6, 11.3, 11.1, and 15.0 pg respectively (Bachmann, 1970 a, b).

Developmental rates for the anurans of Portal, Arizona, have been published (Zweifel, 1968). Determinations of the time interval between the two-cell stage and beginning of gill circulation (stage 20 of Pollister and Moore, 1937) have been taken from that publication. Time intervals between the two-cell stage and stage 16 determined by Dr. Zweifel in the same experiments are published here for the first time. These allow comparison with data on other species compiled by Bachmann (1969).

TABLE 1
Diploid nuclear DNA amounts in eleven species of anurans.

Species	Relative Nuclear DNA Amount			pg DNA	Specimens	Determinations
Bufo bufo	8.19	±0.69	±0.31	15.5	2	5
Bufo cognatus	5.91	±0.49	±0.25	11.2	2	4
Bufo debilis	5.59	±0.22	±0.09	10.6	2	6
Bufo marinus	5.77	±0.07	±0.04	10.9	1	3
Bufo punctatus	5.61	±0.65	±0.27	10.6	2	6
Bufo terrestris	5.75	±0.42	±0.14	10.9	5	10
Rana pipiens	9.48	±0.34	±0.20	17.9	1	3
Rana sphenocephala	7.97	±0.71	±0.29	15.0	2	6
Scaphiopus bombifrons	1.50	±0.15	±0.06	2.8	2	6
Scaphiopus couchi	1.95	±0.07	±0.02	3.6	3	11
Scaphiopus hammondi	1.62	±0.07	±0.03	3.1	2	6

The columns represent relative DNA amount with standard deviation of the sample and standard error of the mean, absolute DNA amounts in picograms calculated from these, and number of specimens and preparations.

RESULTS AND DISCUSSION

Table 1 lists the results of the DNA determinations. Repeated determinations on nuclei from different specimens isolated after either formalin or ethanol-acetic fixation, and stained after a variety of different hydrolysis schedules lead to rather large variation in the results, but tend to cancel out systematic errors introduced by any one preparative method. The DNA values obtained here therefore represent a clear improvement over our earlier estimates (Goin *et al.*, 1968; Bachmann, 1970 a). In particular, the higher ratio between the DNA values for *Bufo bufo* and *Bufo marinus* found in these determinations agrees well with a higher ratio found by Ullerich (1966). The measurements also confirm our earlier finding of the virtual identity of nuclear DNA values in *B. terrestris* and *B. marinus* and reaffirm the value of 15 pg DNA for the diploid DNA amount of *R. sphenocephala* (and Eastern *R. pipiens*). Continued recalibration of the DNA values of certain marker species in our laboratory leads to an increasing reliability of our relative DNA determinations and their calibration in absolute units.

On the basis of these calibrations, *Scaphiopus bombifrons* appears to possess the lowest diploid DNA amount ever recorded for an amphibian. Our earlier determination of the DNA amount in *S. holbrooki* (Goin *et al.*, 1968) corresponds to an absolute value of about 3.2 pg and agrees well with the values recorded here. This emphasizes the striking difference between the earlier value of about 7.1 pg for *S. hammondi* (Goin *et al.*, 1968) and the value of 3.1 pg reported here. The difference is too large to be due to measuring error, and may even be suggestive of polyploidy.

All three *Bufo* species from Portal have intermediate DNA values for the genus. This includes *B. debilis,* while the very similar species *B. retiformis* has a markedly higher DNA amount (Bachmann, 1970 a). The high value for the nuclear DNA of Portal *Rana pipiens* is based on determinations made on a single specimen. Variation in nuclear DNA, both in amount and in kind, among different local populations of "*Rana pipiens*" might result in further evidence on the puzzling problem of evolution in this species group.

The DNA values for *Scaphiopus* (about 3 pg), the three *Bufo* species (about 11 pg) and *Rana pipiens* (18 pg) fall into distinct non-overlapping groups. The same grouping of species is found

when developmental times are compared (Zweifel, 1968, p. 48). Table 2 lists Zweifel's determinations of developmental times between the two-cell stage and stage 16 at various temperatures. Values for the developmental times at 20°C have been interpolated from the data using the equation proposed by Bachmann (1969).

Figure 1 summarizes these data and shows the calculated regression lines between developmental time and nuclear DNA amount. It may be noted that both lines have intercepts. This suggests that there is a minimum timing beyond which the nuclear DNA amount exerts its slowing effect. The close relation between developmental timing and nuclear DNA amount is particularly surprising since the mechanism relating the two must act very indirectly, possibly by way of the nucleic acid metabolism of the growing oocyte.

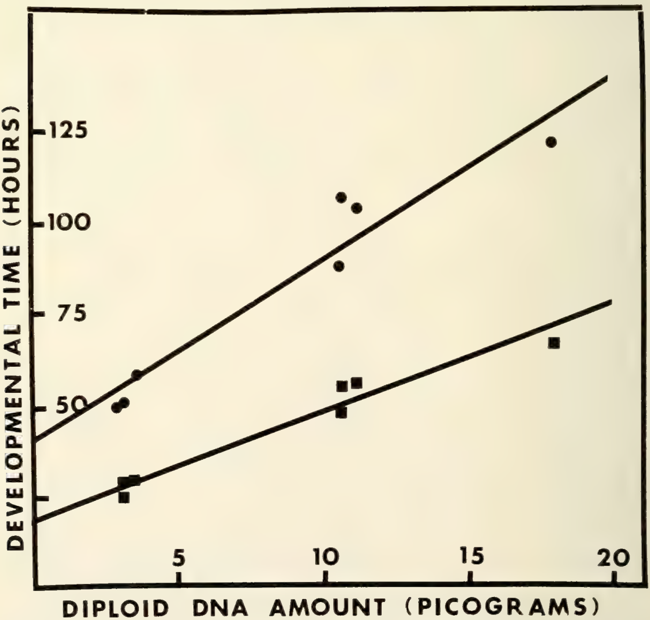


Fig. 1. Developmental rate and nuclear DNA amount for seven anuran species. Times between the two-cell and stage 16 (squares) and stage 20 (dots) against nuclear DNA amounts in picograms.

TABLE 2

Time interval in hours between the two-cell stage and stage 16 in seven species of anurans from Portal, Arizona.

°C	*Bufo cognatus*	*Bufo debilis*	*Bufo punct.*	*Rana pipiens*	*Scaph. bombif.*	*Scaph. couchi*	*Scaph. hammondi*
13.6						91	
15.5					63	63	
15.6	117	101		121			47
	108						
	100						
17.1			77				
18.2		91			33	34	
20.0	(56)	(55)	(48)	(66)	(52)	(29)	(29)
20.3	48					22	
21.0		38					24
21.3							24
24.5	27					15	
	27						
	23						
25.8	25						
26.2			27			11	
31.2	15						
31.5				31			
31.7						8	

These values have been determined by Dr. R. G. Zweifel. Values at 20°C are interpolated from the data.

This is indicated by two observations: (1) polyploid amphibians produced by suppressing the second maturation division do not show an increase in developmental times proportional to the increase in nuclear DNA in every somatic cell; (2) the frog *Ascaphus truei* is the only anuran species known at present which does not fit the DNA-developmental rate correlation. Developmental times are considerably longer (H. A. Brown, cited in Bachmann, 1969) than the relatively low DNA amount of about 7 pg (Macgregor and Kezer, 1970) would suggest. This species is the only anuran species known to have eight functional oocyte nuclei throughout oogenesis (Macgregor and Kezer, 1970). Mediation of the DNA effect on developmental rate by way of oogenesis, for instance through messenger RNA synthesis for early development, would explain the observed correlation as well as these exceptions. The closeness of the correlation in spite of the obviously indirect mechanism involved is

remarkable. A clear relation between nuclear DNA amount and a physiological feature of the whole organism, particularly one of great ecological importance, should subject the nuclear DNA amount directly to natural selection. This may be an indication of one set of factors determining the size of the genome.

SUMMARY

The diploid nuclear DNA amounts of three species of *Scaphiopus,* three species of *Bufo*, and of *Rana pipiens,* all from Portal, Arizona, fall into distinct groups with 3, 11, and 18 pg DNA respectively. The developmental rates of these species from Portal also fall into three distinct groups with *Scaphiopus* showing the fastest rate, *Bufo* developing at intermediate rates, and *Rana* developing slowly. If such diverse factors as environmental adaptation and nuclear DNA amount enter into the determination of the developmental rate of frog species, direct selective effects on genome size can be expected.

ACKNOWLEDGMENTS

I thank Dr. Noel Snyder for providing the specimens used for the DNA determinations, Dean Theodore A. Ashford for travel funds, and Dr. Ronald R. Cowden for his kind permission to let me use the Barr and Stroud Integrating Microdensitometer at the University of Denver. I am especially grateful to Dean William H. Taft for providing funds for an Integrating Microdensitometer for research at the University of South Florida, and to Dr. Richard G. Zweifel of the American Museum of Natural History, who provided the data of table 2 and critically read a first-draft of this paper.

LITERATURE CITED

BACHMANN, K. 1969. Temperature adaptations of amphibian embryos. Amer. Nat., vol. 103, pp. 115-130.

BACHMANN, K. 1970a. Specific nuclear DNA amounts in toads of the genus *Bufo*. Chromosoma, vol. 29, pp. 365-374.

BACHMANN, K. 1970b. Feulgen slope determinations of urodele nuclear DNA amounts. Histochemie, vol. 22, pp. 289-293.

GOIN, O. B., C. J. GOIN, AND K. BACHMANN. 1968. DNA and amphibian life history. Copeia, vol. 1968, pp. 532-540.

MACGREGOR, H. C. AND J. KEZER. 1970. Gene amplification in oocytes with 8

germinal vesicles from the tailed frog *Ascaphus truei* Stejneger. Chromosoma, vol. 29, pp. 189-206.

POLLISTER, A. W. AND J. A. MOORE. 1937. Tables for the normal development of *Rana sylvatica*. Anat. Rec., vol. 68, pp. 489-496.

ULLERICH, F. H. 1966. Karyotyp und DNS-Gehalt von *Bufo bufo, B. viridis, B. bufo* × *B. viridis* und *B. calamita* (Amphibia, Anura). Chromosoma, vol. 18, pp. 316-342.

ZWEIFEL, R. G. 1968. Reproductive biology of anurans of the arid Southwest, with emphasis on adaptation of embryos to temperature. Bull. Amer. Mus. Nat. Hist., vol. 140, pp. 1-64.

University of South Florida, Tampa, Florida.

Quart. Jour. Florida Acad. Sci. 35(4) 1972 (1974)

Some Airborne Algae from North Central Florida

R. T. Parrando and J. S. Davis

Although airborne algae have been collected and studied in several widely scattered locations in the United States (Luty and Hoshaw, 1967), there are no records previous to this study of airborne algae from Florida. The purpose of this paper is to report the algae collected from the atmosphere over the University of Florida campus from January to August of 1969. It is part of the M.S. thesis of the senior author submitted to the Graduate School of the University of Florida.

Materials and Methods

The culture medium used in this investigation was Bristol's medium (Bold and Parker, 1962) enriched by adding 2 drops of a 3 per cent solution of $NaSiO_3$ to each liter. This medium is widely used for the culture of soil algae, soil being the source of most airborne algae.

All plates exposed to the atmosphere, receiving the rain water or coated collector rods from the Rotorod sampled were cultured under fluorescent lamps (Plantgro, Westinghouse) with an intensity of 400 foot-candles and with a 16-8 hr. light-dark cycle. The temperature in the culture room was kept at $25 \pm 2°C$. Viable algae developed into macroscopically-visable colonies after 2 to 4 weeks. Each of these colonies was transferred to a tube containing sterile Bristol's nutrient agar and kept as a stock culture under the lights for subsequent study. All transfers were made in a sterile transfer chamber.

Sampling Methods

Hand-held agar plate. Agar plates containing the modified Bristol's medium were exposed from a moving automobile, from January 1969 to July 1969, according to methods of Brown, Larson and Bold (1964). The plates were held by hand and in a vertical position for 20 seconds to 5 minutes; the speed of the vehicle was 25 mph. After exposure, the plates were placed under the fluorescent lights in the culture room.

Rain water. Rain water was collected in a sterile 125-ml Erlenmeyer flask fitted with a small funnel. The flask and funnel assembly was placed 10 feet above the ground at the time that the rain started falling. Immediately after collecting the water, 2 ml portions were transferred by a sterile 5-ml disposable pipette to agar plates containing sterile Bristol's medium. The water was dispersed over the surface of the agar by swirling the dish on a flat surface, and the plate was then placed under the fluorescent lights in the culture room.

Rottorod sampled. This air sampling apparatus (Metronics Associates, Palo Alto, California, Model 65A) is capable of sampling particles from 5 to 100 microns in size and has a filtering rate of 60 liters per minute. The particles are impacted on the leading surface of the clear plastic rotating collector rods coated with a thin layer of silicone compound (General Electric G-697). Immediately after each 10 minute sampling, the collector rods were taken from the metal holder by sterile forceps and placed in a sterile transit vial. In the laboratory, the exposed rods were taken from the transit vial and streaked on the surface of an agar plate containing the sterile nutrient medium. This procedure was conducted in a sterile transfer chamber. Once streaked, the rods were left on the agar with the silicone-coated surface down so that any viable cells left on the rods would develop into colonies (Brown, Larson and Bold, 1964). The plates were then placed under the fluorescent lights in the culture room. The silicone compound was chosen to coat the rods since it strongly retains the impinged particles.

Ten-minute samples were taken with the Rotorod sampler from the 4 stations listed below located on the campus of the University of Florida, from June 25, to August 19, 1969. Two of these stations were located 12 feet above the ground in open fields and 2 stations were located 12 feet above the roof tops of 2 different buildings. The buildings were chosen for their height and for the lack of algal growth on the roof, as far as the authors could observe.

Station 1. Top of the press box, Florida Field, approximately 90 feet high.

Station 2. Observation platform, Space Sciences Center, approximately 60 feet high.

Station 3. Parking lot (paved), corner of Center Drive and Museum Road.

Station 4. Parade review grounds.

Sedimentation method. Sterile agar plates were exposed from 10 p.m. to 9 a.m. on 5 different occasions, 10 feet above the ground in front of McCarty Hall. These samples were taken on clear and relatively calm nights during the month of July, 1969. After exposure, the plates were placed under the fluorescent lights in the culture room.

The morphology of the algae was studied by making fresh mounts from cultures grown on agar or in the liquid medium. The morphology of the chromatophore of the green algae, an important criterion established by Starr (1955) in the taxonomy of the Chlorococcales, was studied by using a blue light filter as proposed by Friedmann (1966). The presence of a gelatinous matrix was demonstrated by using a solution of methlene blue. Sudan IV was used to determine the presence of fat or oil within the cells, and solutions of I_2-KI were used to demonstrate the presence of starch. The number and position of the nuclei was determined by the acetocarmine technique according to the method of Cave and Pocock (1951).

In order to promote the formation of zoospores in the zoospore-producing genera of the Chlorococcales, the following technique proved successful. A culture was started from a stock culture by streaking the algae on fresh agar plates containing sterile nutrient medium. When the culture was growing vigorously, the plate was flooded with sterile liquid nutrient medium or sterile distilled water, and the culture was then placed under the fluorescent lights for 24 hours. Microscopic observations were made the following morning.

All algal isolates were surveyed, and only Chlorophyta and Cyanophyta were present. All the blue-green isolates were identified; Dr. Francis Drouet determined a number of the species in the Oscillatoriaceae. Although all the filamentous species of the Chlorophyta were identified, only 80 of the coccoid Chlorophyta were identified because of time limitation; all of these belonged to the orders Chlorococcales or Chlorosphaerales. In species determination of the coccoid members of the Chlorophyta, Starr (1955), and Brown, Larson and Bold (1964) emphasized the necessity of long periods of observations of unialgal cultures before successfully disposing of the taxonomy of most of these genera.

RESULTS

Hand-held plates. Seventy three samples were taken by this method, 39 of which contained viable algae, yielding 193 colonies. The usual number of impactions per plate ranged from 4 to 6; the speed of 25 mph was found to yield the most impactions. The number of impactions was slightly higher during the spring and summer months than during the winter. Twenty-five species were recovered by this method of sampling. The most common species thus obtained was the blue-green *Schizothrix calciola*, with 23 impactions.

Rain water. Thirty six plates were inoculated with rain water, 12 of which developed algal colonies after 2 to 3 weeks under the fluorescent lights. Twenty unialgal cultures were obtained. *Schizothrix calcicola* was the only blue-green recovered from rain water. The most common species of the green algae thus obtained were *Chlorella vulgaris, C. saccharophila* and an unidentified species of *Oocystis.*

Sedimentation method. Five agar plates were exposed, 4 of which were positive with 31 colonies isolated into unialgal cultures. Only by this method was *Scytonema ocellatum* recovered. Several members of the Chlorophyta were also obtained by sedimentation.

Rotorod Sampler. Sixty samples were taken by this method, 42 of which were positive, yielding 189 isolates when grown under the fluorescent lights. Thirty-four samples were taken during the morning hours, between 9 a.m. and 12 noon. Twenty-one of these samples were positive, yielding 53 colonies which were isolated into unialgal cultures. The morning samples yielded an average of 2.6 impactions per cubic meter of air sampled. Twenty six samples were taken in the afternoon hours, between 2 p.m. and 6 p.m. during the sampling period. In contrast with the morning samples, all but 2 of the afternoon samples developed algal colonies when placed under the fluorescent lights. A total of 136 colonies were isolated into unialgal cultures from the afternoon sampling, yielding an average of 8.7 impactions per cubic meter of air. In the counting of the number of impactions, the assumption was made that each impaction was from a single cell which produced a single colony when the collector rod was streaked on the agar surface.

The largest number of impactions obtained by the Rotorod sampler was recovered during the dry part of the sampling period, when the total amount of precipitation recorded was 0.10 inches of rain.

TABLE 1
Number of algal isolates obtained by 4 sampling methods

Species	Hand Held Plates	Rotorod Sampler	Rain Water	Sedimentation	Total
CHLOROPHYTA					
Ankistrodesmus sp.			1	1	2
Chlamydomonas globosa Snow	1	6			7
Chlamydomonas sp.	1			1	2
Chlorella luteoviridis Chodat	1	1	1		3
Chlorella saccharophila (Kruger) Migula	3	9	3		15
Chlorella vulgaris Beijerinck	3	3	4		10
Chlorococcum ellipsoideum Deason & Bold		2			2
Chlorococcum scabellum Deason & Bold				1	1
Chlorosarcina sp.		2			2
Chlorosarcinopsis aggregata Arce & Bold		1			1
Chlorosarcinopsis dissociata Herndon	1				1
Chlorosarcinopsis minor Herdon		1			1
Chlorosarcinopsis sp.	1				1
Hormidium flaccidium A. Braun	1		1		2
Nannochloris bacillaris Naumann	1	1			2
Neochloris sp.	1				1
Oocystis polymorpha Grover & Bold	4	5	2		11
Oocystis sp.		1			1
Scenedesmus quadricauda	4	1			5
Oocystis sp.'			3		3
Spongiochloris incrassata Chantanachat & Bold				1	1
Stichococcus bacillaris Näg.	3				3
Stichococcus mirabilis Lagerh.	3				3

The temperature during the sampling period ranged from 20°C at night to 37°C during the day. The wind direction seemed to have little influence on the number of impactions. However, a wind speed of 15 mph yielded samples with the largest number of impactions. Partly cloudy skies favored higher numbers of impactions than did clear skies. The relative humidity during the sampling period ranged from 40 per cent to 100 per cent on several occasions during the month of July.

TABLE 2
Number of algal isolates obtained by 4 sampling methods

Species	Hand Held Plates	Rotorod Sampler	Rain Water	Sedimentation	Total
CYANOPHYTA					
Anabaena flos-aquae (Lyngb.) Breb.	1				1
Anabaena variabilis Kützing	5	1			6
Anabaena sp.		2			2
Calothrix parietina (Nägeli) Thuret	4	1			5
Fischerella ambigua (Näg.) Gom.	1	1			2
Oscillatoria formosa Bory.	1				1
Oscillatoria submembranacea Ard. & Straff.	1				1
Nostoc commune Vaucher	7				7
Nostoc muscorum Ag.	5				5
Nostoc sp.	1	1			2
Porphyroshiphon notarisii (Menegh.) Kütz	1				1
Scytonema ocellatum Lyngbye				2	2
Schizothrix calcicola (Ag.) Gom.	23	5	1	3	32

Eighteen species were recovered using the Rotorod sampler. Six of these species belonged to the blue-green algae and 12 species to the green algae. The most common genera recovered by the Rotorod sampler were *Chlorella, Chlamydomonas, Oocystis* and *Schizothrix.*

The identified species obtained by the various collection methods are listed in Tables 1-2.

DISCUSSION

Schlichting (1969) indicated that several workers in the United States and other countries have found a number of diatoms species, yellow greens, and Euglenoids, from the air. The lack of diatoms can not be the fault of an inappropriate culture medium, for other investigators who have reported diatoms from the air used the same basic inorganic medium used in this investigation. Furthermore, our medium was made more favorable to diatoms by the addition of silicon. It seems clear that Florida air over the University Campus from January to August of 1969 contained very low diatom concentrations. The *Euglens* omissions from our collections may well be due to our culture medium which was not enriched with organic

carbon compounds. These missing algal groups also might be due to our algae-poor soil (Smith, 1944; Smith and Ellis, 1943), which is the source of most airborne algae.

Although many workers have reported *Chlorococcum* species to be among the most common of airborne algae, only 3 isolates of 2 species were found in the investigation. The infrequently reported *Schizothrix calcicola* was the most commonly occurring airborne alga in our area.

LITERATURE CITED

BOLD, H. C., AND PARKER, B. C. 1962. Some supplementary attributes in classification of *Chlorococcum* species. Arch. Mikrobiol., vol. 42, pp. 267-288.

BROWN, R. M., D. A. LARSON AND H. C. BOLD. 1964. Airborne algae: their abundance and heterogeneity. Science, vol. 143, pp. 583-585.

CAVE, M. S., AND M. A. POCOCK. 1951. The aceto-carmine technique applied to the colonial Volvocales. Stain Technol., vol. 26, pp. 173-174.

FRIEDMANN, I. 1966. Microscopy of algal chromatophores. Phycologia, vol. 6, pp. 29-36.

GROOVER, R. D., AND H. C. BOLD. 1968. Phycological notes 1. *Oocystis polymorpha* sp. nov. Southwestern Nat., vol. 13, pp. 129-135.

LUTY, E. T., AND R. W. HOSHAW. 1967. Airborne algae of the Tucson and Santa Catalina mountain areas. Jour. Arizona Acad. Sci., vol. 4, pp. 179-182.

SCHLICHTING, H. E. 1969. The importance of airborne Algae and Protozoa. APCA Journal, vol. 19, pp. 946-951.

SMITH, F. B. 1944. The occurrence and distribution of algae in soils. Proc. Florida Acad. Sci., vol. 7, pp. 44-49.

SMITH, F. B., AND H. R. ELLIS. 1943. Preliminary report on the algal flora of some Florida soils. Proc. Florida Acad. Sci., vol. 6, pp. 59-65.

STARR, R. C. 1955. A comparative study of *Chlorococcum meneghini* and other spherical, zoospore-producing genera of the Chlorococcales. Indiana Univ. Publications, sci. ser., no. 20, 111 pp.

Department of Botany, University of Florida, Gainesville, Florida 32601.

Quart. Jour. Florida Acad. Sci. 35(4) 1972 (1974)

Bird Remains from Pre-Columbian Middens in the Virgin Islands

PIERCE BRODKORB

DURING excavation of kitchen middens in the American Virgin Islands Ripley P. Bullen of the Florida State Museum collected a number of bird bones which he has asked me to study. In April 1960 he worked at the Magens Bay midden on the north shore of St. Thomas. On the island of St. John he studied sites at Turtle Point on Turtle Bay, at Francis Bay, and at Coral Bay. All the middens are of pre-Columbian age with approximate dates of A.D. 500-1000, but Mr. Bullen believes that the Magens Bay site is the youngest and the Coral Bay site the oldest. From Coral Bay only a single indeterminate shaft of a humerus was obtained. Identified remains from the other localities are listed below.

The only previous records of bird remains from the Virgin Islands are from Magens Bay and from middens on the island of St. Croix (Wetmore, 1918, 1937).

1. *Puffinus lherminieri* Lesson. Audubon's Shearwater. Magens Bay, 5 bones, 2 individuals. Turtle Point, 8 bones, 6 individuals. Wetmore also recorded this widespread seabird from Magens Bay and from St. Croix.

2. *Sula leucogaster* (Boddaert). Brown Booby. Magens Bay, 2 bones, 1 individual. Recorded from Magens Bay and St. Croix.

3. *Fregata magnificens* Mathews. Magnificent Frigate-bird. Magens Bay, 4 bones, 1 individual. Also recorded by Wetmore.

4. *Nyctanassa violacea* (Linnaeus). Yellow-crowned Night Heron. Magens Bay, 1 ulna. Francis Bay, 1 ulna. Recorded from Magens Bay.

5. *Butorides virescens maculatus* (Boddaert). West Indian Green Heron. Magens Bay, right femur, length 41 mm. Seven Floridian specimens of the mainland subspecies, *B. v. virescens* (Linnaeus), have femur lengths of 47.0-48.7 mm. Oberholser (1912) showed that resident green herons from the West Indies are smaller than the northern migratory form. This is the first fossil record of the species from the West Indies.

6. *Anas americana* Gmelin. Baldpate. Magens Bay, humerus. Reported from the St. Croix midden. This duck is a winter visitant to the West Indies.

7. *Nesotrochis debooyi* Wetmore. Magens Bay, 1 bone. Francis

Bay, 3 bones, 2 individuals. Magens Bay is the type locality of this extinct genus of large rail. It has also been recorded from St. Croix and Puerto Rico (Wetmore, 1922) but not previously from St. John. Although sexual dimorphism in size is marked in the Rallidae, it appears that this flightless bird may also show geographic variation, as published measurements of Puerto Rican fossils exceed those from the Virgin Islands.

8. *Sterna fuscata* Linnaeus. Sooty Tern. Magens Bay, 2 right humeri. Turtle Point, right and left humeri. This seabird occurs in tropical waters throughout the world, but the only previous fossil records are from the Bahamas and St. Helena (Brodkorb, 1967). In *Sterna* the distal end of the humerus is more compressed and the brachial depression deeper than in *Anous*. In *S. fuscata* the external edge of the ectepicondylar process is nearly straight or a little concave, so that its tip is only slightly set off from the rest of the process; in *S. anaethetus* and *Anous* the external edge of the process is constricted in the middle, so that the free half forms a distinct spur. In *S. anaethetus* the shaft of the humerus is more slender than in the other two species.

LITERATURE CITED

BRODKORB, PIERCE. 1967. Catalogue of fossil birds, Part 3 (Ralliformes, Ichthyornithiformes, Charadriiformes). Bull. Florida State Mus., vol. 11, no. 3, pp. 99-220.

OBERHOLSER, HARRY C. 1912. A revision of the subspecies of the green heron (Butorides virescens [Linnaeus]). Proc. U. S. Nat. Mus., vol. 42, no. 1916, pp. 529-577.

WETMORE, ALEXANDER. 1918. Bones of birds collected by Theodoor de Booy from kitchen midden deposits in the islands of St. Thomas and St. Croix. Proc. U. S. Nat. Mus., vol. 54, no. 2245, pp. 513-522, pl. 82.

———. 1922. Bird remains from the caves of Porto Rico. Bull. Amer. Mus. Nat. Hist., vol. 46, pp. 297-333, figs. 1-25.

———. 1937. Ancient records of birds from the island of St. Croix with observations on extinct and living birds of Puerto Rico. Jour. Agr. Univ. Puerto Rico, vol. 21, no. 1, pp. 5-16, pl. 1.

Department of Zoology, University of Florida, Gainesville, Florida 32611.

QUARTERLY JOURNAL
of the
FLORIDA ACADEMY OF SCIENCES

VOLUME 35

Editor

PIERCE BRODKORB

Published by the

FLORIDA ACADEMY OF SCIENCES
Gainesville, Florida
1972

Publication Dates of Volume 35

Number 1: August 25, 1972

Number 2–3: November 5, 1973

Number 4: March 15, 1974

New Taxon Proposed in Volume 35

Trachurus margaretae Berry and Cohen 191

CONTENTS OF VOLUME 35

NUMBER 1

The Armadillidae of Florida (Isopoda, Oniscoidea) *George A. Schultz* 1
Reassignment of *Balanus tintinnabulum maroccana* Broch *Dea B. Beach* 5
Intestinal parasites of the lizard *Lygosoma laterale* *Garnett R. Brooks* 8
Observations on the arboreal snail *Orthalicus floridensis* *Alan K. Craig* 15
Nereid shell blisters in the southern quahog clam
John L. Taylor and Carl H. Saloman 21
Occurrence of a rare skate in the western North Atlantic
Robbin R. Blackman 27
First Gulf of Mexico record of *Ranzania laevis*
Robert W. Topp and David L. Girardin 29
Five-year creel survey of two Florida lakes
Forrest J. Ware, Wesley V. Fish, and Louie Prevatt 31
The presence of *Hyla squirella* in the Bahamas *Ronald I. Crombie* 49
Additions to the Pleistocene avifauna of Arredondo, Florida
Carl David Frailey 53
Avifauna of Little Tobago Island *James J. Dinsmore* 55
Birds of the Lluidas Vale (Worthy Park) region, Jamaica
Alexander Cruz 72

NUMBER 2–3

First occurrence of the violet goby in Georgia
Paul L. Wolf, Sheryl F. Shanholtzer and R. J. Reimold 81
Vegetational changes in the National Key Deer Refuge-II
Taylor R. Alexander and John D. Dickson III 85
Composition of *Thalassia testudinum* and *Ruppia maritima*
Gerald E. Walsh and Thomas E. Grow 97
Noteworthy marine fishes from eastern Louisiana *Jerry G. Walls* 109
Antarctica, isostacy, and the origin of frogs
Coleman J. Goin and Olive B. Goin 113
Characteristics of the western Atlantic reef-fish fauna
Carter R. Gilbert 130
Annotated checklist of the Boynton Beach hammock
Daniel F. Austin and Joanne G. Weise 145
A sediment trap for use in soft-bottomed lakes
Frank G. Nordlie and John F. Anderson 155
New records for fishes in South Carolina waters
David M. Cupka and Robert K. Dias 158

Number 4

Notes on Parasites of gray squirrels from Florida
P. C. Parker, E. J. Riggs, and R. B. Holliman 161

Occurrence of two trematodes in Florida anoles
Richard Franz and Sam R. Telford, Jr. 163

Reproductive rates in white-tailed deer of Florida *Richard F. Harlow* 165

Food of the barn owl on Grand Cayman, B. W. I. *David W. Johnston* 171

Balanomorph barnacles on *Chrysemys alabamensis*
Crawford G. Jackson, Jr., and Arnold Ross 173

Synopsis of the species of *Trachurus* (Pisces, Carangidae)
Frederick H. Berry and Linda Cohen 177

Defensive behavior in *Rana areolata* and *Hyla avivoca* *Ronald Altig* 212

Commercial fishery on Lake Okeechobee, Florida *Lothian A. Ager* 217

Nuclear DNA and developmental rate in frogs *K. Bachmann* 225

Some airborne algae from North Central Florida
R. T. Parrando and J. S. Davis 232

Bird remains from pre-Columbian middens in the Virgin Islands
Pierce Brodkorb 239

FLORIDA ACADEMY OF SCIENCES

Institutional Members for 1972

American Medical Research Institute
Archbold Expeditions
Barry College
Edison Community College
Florida Atlantic University
Florida Institute of Technology
Florida Presbyterian College
Florida Southern College
Florida State University
Florida Technological University
Jacksonville University
Manatee Junior College
Miami-Dade Junior College
Mound Park Hospital Foundation
Ormond Beach Hospital
Rollins College
St. Leo College
Stetson University
University of Florida
University of Miami
University of South Florida
University of Tampa
University of West Florida

FLORIDA ACADEMY OF SCIENCES

Founded 1936

OFFICERS FOR 1972

President: DR. RICHARD E. GARRETT
Department of Physics, University of Florida
Gainesville, Florida 32611

President Elect: DR. JAMES G. POTTER
Department of Physics, Florida Institute of Technology
Melbourne, Florida 32901

Secretary: DR. ROBERT W. LONG
Department of Botany, University of South Florida
Tampa, Florida 33620

Treasurer: DR. RICHARD A. EDWARDS
Department of Geology, University of Florida
Gainesville, Florida 32611

Editor: DR. PIERCE BRODKORB
Department of Zoology, University of Florida
Gainesville, Florida 32611

Membership applications, subscriptions, renewals, changes of address, and orders for back numbers should be addressed to the Treasurer

Correspondence regarding exchanges should be addressed to

Gift and Exchange Section, University of Florida Libraries
Gainesville, Florida 32611